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Electrochemical and Metallurgical Industry

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NEW YORK, SEPTEMBER, 1906.

CONTENTS.

Reinforced Concrete and Cement in Furnace Construction.

The great San Francisco disaster showed well that the fireproof qualities of any structure in which cement entered had been greatly underestimated. The great mechanical hardness of cement when once well "set" shows that there is a strong chemical bond between the water and the complex lime-aluminate-silicate formed by the hydration. This fact reduces the vapor pressure as regards water to a low figure even at a low red heat and preserves mechanical hardness. Mr. David H. Browne, in his description of concrete electrolytic vats, published in our first volume, stated that it was possible to slowly heat these vats to a low red heat. Cement is also used as a bond for the hearth of silver cupelling furnaces. It has even been used for the same purposes for lining the long rotary kilns. Here it is subjected to a terrific heat, and acts simply to hold particles of ganister or silica sand together at low heat.

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"Cement mortar" has also been used, we are reliably informed, in building the brick walls of metallurgical furnaces that are put to an inside heat approximating 1,600° C. It has the useful effect of making the outside wall one piece mechanically, and prevents cracks if properly reinforced by external buckstaves or other iron. By such a construction the buckstaves can be spaced farther apart, and the arrangement is far superior to iron plates and besides considerably cheaper. The same engineer proposes to use reinforced concrete for the external shell, and no good reason against its use here can be induced. provided walls are thick enough for the temperature gradient to be low, and not subject the concrete to an excessive heat. Reinforced concrete is, of course, used for furnace foundations, dust chambers and stacks. We hope to be able to publish some time an article describing this interesting phase in the development of metallurgical engineering. The use of cement as an ingredient in "semi-refractory" construction is extremely promising.

Electric Steel and Sociology

The study of sociology is hardly within the province of this journal, nevertheless, we feel it our duty to refer to some recent work of the United States Government that is of great sociological interest, because of an extraordinary misapprehension of the object of the investigation that seems to have arisen in the mind of the public. It has been asserted that the barbarous people inhabiting the Far West have made great progress in their knowledge of the arts and science of civilization, and that it is no longer possible for the adventurous traveler in that interesting region to astonish the natives by means of the childish toys with which he was formerly wont to excite their wonder and admiration. Following the policy

of enlightened paternalism, which so brilliantly distinguishes our Government, Dr. Day, last year, undertook the investigation of this important subject among the native tribes inhabiting Portland, Ore. For this purpose he hit on the ingenious idea of testing their knowledge of the metallurgy of steel by exhibiting to them a simple electrical experiment. Incredible as it may seem this interesting and instructive experiment on the state of the scientific knowledge of a Western people, has been described in some of the daily papers as though it were a real metallurgical investigation.

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That there is absolutely no excuse for such an astonishing blunder may be readily seen by referring to an article in the *Technology Quarterly* of June, 1906. Here Prof. Robert H. Richards, of the Massachusetts Institute, describes the electric furnace shown to the inhabitants of Portland under Dr. Day's auspices. "It consists of a hollow cylinder standing on end, 12 inches in diameter and 36 inches high inside." The remarkable effect of the experiment on the natives conclusively demonstrates the untrustworthy nature of the traveler's tales mentioned above. "There was boundless enthusiasm among the Portland people who had gathered to see it, when * * * * 200 pounds of white-hot steel was tapped from it." And then Prof. R. H. Richards adds, with subtle humor: "It (the furnace) is still in the experimental stage as to the means of controlling the contents of the steel in silicon, carbon, manganese, sulphur and phosphorous. This control, as well as the means for obtaining sound ingots free from bubbles, will have to come by experiment. At the time of writing it does not look as if any of these would give serious trouble." He concludes with an ironical estimation of the cost of producing a ton of steel. To anyone but superficially familiar with the work of Héroult and others, it is obvious that the highly-trained men of science employed by the United States Government would not waste money on a crude experiment of this kind, except for the sociological purpose described. But it is a matter of no small concern to us that some of the daily papers of the East, and presumably their readers, are in a state of intellectual development but little more advanced than that of the barbarians of the Pacific Coast.

Pre-Heaters and Electric Furnaces.

The cost of a heat unit of electrical energy is from two to forty times the cost of the same unit in the combustion value of coal. The relative ratio, of course, depends on the price of the two sources of energy in any one locality. With electrical power at 3 mills per horse-power-hour and coal at $2.00 per ton, the ratio is about fifteen. With cheap electric power at 1½ mills, and coal at $8.00, which happens in several localities, as in the French Alps, and to a less extent in inland Norway, the ratio is only two. While at a coal field with slack at a very low figure, not much over cost of mining, the ratio is forty. The use of electric heating comes from the high thermal efficiency of electric furnaces. The efficiency of an electric furnace is usually over 75 per cent. and often as high as 95 per cent, whereas the efficiency of heating by coal is in evaporating or drying or in a boiler, rarely as high as .75 per cent, and is sometimes as little as 3 to 7 per cent in indirect heating, crucible melting or in muffle heating. By a careful use of "metallurgical calculations" the cost of electrical heating can be figured exactly, and the able metallurgist can reckon thus the relative value of two methods for any given set of conditions.

* * *

Now, the efficiency of a coal or gas furnace varies greatly in the operation. If a pyrometer be placed in such a furnace in the charge, the rise in temperature is at first a straight line, but finally curves, and at the end reaches a straight line parallel to the horizontal co-ordinate. In other words, the first efficiency is high, but is gradually reduced to zero, for radiation and serviceable heat in chimney gases absorb all the energy of combustion, and at 1,400°—1,900° C. in most instances all the heat of the fuel is lost. Now, if the furnace were designed to use a combination of gas or coal heating for the first part of the metallurgical work and electric heating for the last part of the work, an average high efficiency would be attained, while the "commercial efficiency" or cost of each useful calory would be reduced to lowest possible point. Such is the function, indeed, of "pre-heaters," either two furnaces combined or a fuel-heated furnace separate but directing its heated product into the electrical furnace. A somewhat broader use of this principle is seen in the great "direct" steel mill where heat of pig iron never leaves the material until the finished product is allowed to cool so that it can be loaded on the railroad car.

* * *

The new steel plant at Syracuse, using Dr. Héroult's process, uses the open-hearth furnace for the first and easy part of the work, while the difficult high-temperature refining is effected by the Héroult electric furnace. The practical combined preheater as a shaft furnace directly on top of an electric furnace, so that the two are really one metallurgical instrument, has not been yet proved publicly practical, at any rate commercial, although we have private information of several interesting attempts that are likely to eventually be successful. Most electric furnaces are used for operations only possible by electrical heating, as reduction of alumina, graphitizing articles and the manufacture of carborundum. When the practical solution of the "pre-heater" is worked out and made successful, it will open large vistas of successful electrometallurgical operations that are most alluring and wonderful, and the demand from this source on the manufacturers of prime-movers and electric generators cannot be estimated, because of its possible magnificence.

Simplified Spelling.

President Roosevelt's order to the Public Printer that all messages and documents from the White House shall be printed according to the recommendations of the Mathews committee, has been the subject of much comment in the daily press. Some twenty years ago or so Fürst Bismarck gave out an ukase that all reports, etc., of the different departments of the German Government should be written or printed in the so-called German type, instead of the international Roman type. His order was severely criticised, but his will prevailed, and has undoubtedly done much towards the preservation of the "German alphabet." Not so very long ago we noticed an excellent book, brought out by a prominent German publisher, on a scientific subject of world-wide interest—namely, on

systems of physical and electrical units and measurements—printed in the German type. It is almost incredible that Germans should fail to realize that to many men in other countries who understand the German language, and who would be interested in the subject, a book printed in German letters looks very much like one printed in Russian or Chinese characters. If Fürst Bismarck's well-meant, but undoubtedly retrogressive order could have so much success, it seems certain that President Roosevelt's progressive and broad-minded order will be far more effective in the end. Those who might expect a very speedy development in this direction should consider that in journalism there is a distinct inter-relation between editor and printer, with enough existing trouble and no necessity to borrow any.

* * *

We have referred to this whole matter because in the discussion of President Roosevelt's order it seems to have been generally overlooked that a single branch of the system of our Government has already done pioneer work for simplified spelling in a special field, namely, the United States Patent Office, in the spelling of chemical words. While others spell sulphide or sulfide, they spell sulfid, and this method will undoubtedly prevail in the end, on account of its simplicity. For the present every chemist and metallurgist uses his own way of spelling chemical terms, and this would seem to be part of his chemical individuality. For this reason we have given the widest latitude to our contributors in this respect. The real international language of chemists as well as engineers employs formulas and drawings. A single chemical equation is immediately understood all over the world. Some improvements, though, would be desirable; thus France should adopt N instead of Az. In the symbols used by physical chemists, on the other hand, there reigns a chaos which is even worse than that which still exists in the symbols employed by electrical engineers. There is at least a desire and an endeavor on the part of electrical engineers to get together and devise a uniform system of electrical notation. But how far we are still from the realization of such a plan is indicated, for instance, by the fact that the Germans, almost to a man, insist on retaining the letter w (widerstand) for electrical resistance, while everybody else uses r.

Extension of the Senses by Scientifc Instruments

Principal Griffiths, in his Olla Podrida on scientific progress, in his presidential address before the British Association for the Advancement of Science, touched on ions, chemical thermodynamics, scientific education of the British youth, university extension and other things too divers to mention. At the end of this recital from his mental scrap book, he discussed the broad proposition of the growing multiplicity of our sensible knowledge due to the advance in scientific experimenting. The eye is a continuous photographic camera, and the camera preserves the record of its vision in the negative plate. Here we can distinguish between our natural senses and the artificial senses,—the creations of experimental science. The natural senses are those of touch, smell, taste, seeing and hearing in the main. They have simple extensions as the act of "hefting a stone" to judge roughly of its weight against that of a dimly remembered standard, is, of course, an adjunct sense, that of muscular co-ordination. But to the electrical engineer,—especially to those who have fussed with batteries and motors from their childhood up,—the indications of the ammeter, of the "gasing" on the plates of a storage battery are not unseen phenomena (a contradictory pair of words) but as real to him as is the blowing of the wind to the average mortal. In short, the ammeter is his electrical eye. The layman is apt to deny the reality of electricity, as the Christian Scientist is apt to deny the reality of the entire external world. But the Christian Scientists of our acquaintance do not give an imaginary yell when pricked by an actual pin, as a general rule, and a shock of "200 volts to the ground" ought to convince the most skeptical of the actuality of electricity. The difference between the expert and the ordinary man lies in the fact that the phenomena in one case are seen every day and understood every day, while in the other they are neither seen nor understood. The difference, let it be stated, is in the "subject" and not in the "object," to use convenient metaphysical terms.

* * *

There is a further difference between our natural senses and our artificial and extended senses, and that difference is found in the fact that man can reject old pieces of apparatus and install improved ones. On the other hand he can only train and educate his natural senses within the limitations of their physical being as developed by the course of evolution for the use of savage man. Marconi can tear up a coherer and put in a new one, but no one would care at the present time to have a new ear grafted in his head. It should be noted that both the ear and the coherer are detectors of two kinds of wave-motion. The ear detects the wave-motion due to the change in pressure in the air, while the coherer detects the difference in the electro-magnetic displacements, which take the form of true wave-motion. A second difference is due to the permanence and accuracy of the indications of our artificial senses. The best illustration of this is seen in the photographic maps of the heavens which the Harvard University observatory sends out to astronomers in different parts of the world to study. These are permanently correct and enduring. The eye of the furnace-man working the "Ziervogel process" at the Argo smelter at Denver, can err in his judgment of the heats from copious indulgence in colored aqueous solutions of ethyl alcohol, but Prof. Howe's determinations of the physical constants are correct, lasting, and in fact give the essential details of this metallurgical operation.

* * *

This wonderful mechanical age, too mechanical as many think, perhaps is due to the magnified and projected extension of our senses by the advance in experimental science. The effect on the faculties of the growing generations who are accustomed to lisp at the age of two years on the long distance telephone, will undoubtedly be greater than upon those who now occupy the stage and have seen the advance at a later period of their lives. Immanuel Kant gives in his Critic of Pure Reason a dictum concerning our natural knowledge. This was to the effect that the indications of our senses are always imperfect, and sometimes misleading, but that if care and discrimination are used, the true can be sifted from the false, and an approximation of the truth can be secured. This saying of a metaphysician, who was also a physicist, is justified more and more by the march of scientific advance.

The Iron and Steel Market.

The feature of August has been the excitement in the pig iron market. Purchases of pig iron have been made freely for delivery through the first quarter and first half of next year, which is almost unprecedented for August, particularly as regards Bessemer and basic. Prices have been advancing sharply, the advance beginning in July, before there were any large purchases, except of Southern iron, and altogether the advances have presented the quite unusual feature of preceding rather than following the heavy buying. Ordinarily the large buyers at least succeed in getting in at near the bottom, but in this case they have freely covered at advances.

The total sales of pig iron during August have totaled many hundred thousand tons, a large total for any month, and particularly large for August, which is usually a dull month. Advances have ranged from 50 cents to more than a dollar, the month closing with prices from $1 to $2 above the low point reached in the late spring or early summer.

There has been a complete reversal of sentiment among buyers of pig iron as regards the prospective supply. The pendulum of sentiment had swung too far in one direction, and it will probably be found later to have swung in August too far in the opposite direction. During the second quarter the prevailing sentiment among buyers evidently was that pig iron production would be greatly increased in the second half, with perhaps a decline in demand. Production decreased towards the end of the first half, but merely through weather conditions and the necessity for relining an unusual proportion of merchant furnaces. Labor conditions in the South were a contributory cause. Buyers suddenly lost faith in an increase in production through the completion of new furnaces, and the foundries, but not the steel works, started accumulating stocks against a scarcity, thus precipitating the condition which they feared.

As a matter of fact, production is bound to increase materially. The furnaces which were operative Jan. 1, 1906, will make as much pig iron in the second half, taken as a whole, as they did in the first half, while the new furnaces completed during the first half, having a rated capacity of 880,000 tons a year, will naturally contribute more than in the first half. There are scheduled for completion in the second half additional furnaces having a rating of 975,000 tons a year, and in the first half of 1907 furnaces having a rating of 818,000 tons. Invariably some such plans miscarry, and the actual results will be less than the anticipation, but still quite large. Production of pig iron in 1902 and 1903 was about 18,000,000 tons per year. Following the off-year of 1904 it jumped to 23,000,000 tons in 1905, and in the first half of this year was at the rate of 25,000,000 tons. It is safe to predict that in the second half it will be at a rate exceeding 26,000.000 tons, and that available capacity will be equal to a rate of 27,000,000 tons during the first half of 1907. It is true that the present rate of increase is less than that from 1903 to 1905, but the iron trade cannot continually stand so great an increase as that was. There was undue excitement as to pig iron during August, and it will probably be found some time in the first half of next year that buying and price advancing was overdone, and this will result in a decline, which is likely to reach serious proportions if assisted by financial and political uncertainties.

From surface indications the iron and steel markets are regarded as remarkably strong. The visible future of the market is usually taken as covering only six or nine months at most, and it is extremely bright. The great bulk of the merchant pig iron production is already sold, and contracts and definite orders are on books for the various steel products, covering in most cases the great bulk of the prospective production.

The Carnegie Steel Co. has definitely withdrawn from the market on standard rails for this year's delivery, being already oversold. It has advanced prices on light rails a dollar a ton. being sold up for two or three months, and has advanced its price on sheet bars a dollar a ton.

Sales of wire products have been exceptionally heavy, and would be large for any month, while August is usually quiet. The programme of restriction of output for July and August was abandoned, being found unnecessary. In the past two years it was followed, and with excellent results.

Pig Iron.

Against a steady market of $17.25, valley, for Bessemer pig during the first half, sales were made early in August at $17.75, valley, including 30,000 tons for first quarter of next year to the Jones & Laughlin Steel Co. and 70,000 tons for first half to the Youngstown Sheet & Tube Co. Concurrently sales were made for the fourth quarter of this year at $18.00. Later sales were made for first quarter and first half at $18.25, valley, and for early delivery and fourth quarter at $18.25 on up to $18.75. The month closed with $18.25 as the absolute minimum, and $18.50 to $18.75 being paid for early delivery, according to circumstances. Outright sales of Bessemer and sales subject to monthly adjustment amounted in August to 250,000 tons or more. There is still a large unsatisfied demand, and it is certain that large steel producers will be compelled this winter to regulate their steel output to the iron supply, which they have been occasionally forced to do in the past.

Basic has been in active inquiry, but has moved less freely, because furnaces have held off. Sales have been made for first quarter at $18.00, valley, and the market is well established at that figure, with prospects that $18.25 may be obtained.

Southern iron has advanced sharply, with heavy purchases, the month closing with the market practically at $15.00, Birmingham, for No. 2, for delivery next year, and $15.50 to $16.00 being obtained for earlier delivery. The coal strike in Alabama was settled during the month, relined furnaces are coming in, and weather conditions becoming more favorable, indicating that the advance in Southern iron may have been overdone, from the minimum of $13.00 in June and the market of $13.50 at the time of our last report.

Northern foundry iron has advanced freely, with liberal buying through the first quarter and first half. The market for forward delivery of No. 2 stands at $18.85 to $19.10, Pittsburg; $19.50 to $19.75, Chicago, and $19.25 to $19.50, Philadelphia.

Billets and Sheet Bars.

There is only a nominal market in billets, at $28.00 to $29.00, Pittsburg, for Bessemer, and $29.00 to $30 for open-hearth. Only occasional lots can be picked up. Small billets command merchant bar prices, equal to $33.60 per gross ton. The Carnegie Steel Co., on Aug. 20, announced its price for September for sheet bars at $30, Pittsburg, for long bars, with the usual extra of 50 cents for bars cut to specifications, on contracts subject to monthly price adjustment. Such contracts are unimportant, but it is certain that on the more important quarterly adjustment contracts, the price will be named at this or a higher figure, for fourth quarter. The third quarter price was $29. The open market on odd lots has been $30 to $33.

A new Bessemer steel producer was added to the ranks during August, the Youngstown Sheet & Tube Co., Youngstown, Ohio, having completed a standard two 10-ton vessel plant in the record time of a little over a year. For several years it has operated skelp mills, sheet mills and a very complete merchant pipe plant. The addition just completed includes a large blooming mill, which makes no billets, but will supply blooms and slabs for the old skelp mills, a new mill for billets and small billets and a new sheet bar mill. The management hopes shortly to reach 2,000 tons of ingots a day, but the billet, sheet bar and skelp capacity is in excess of this, so that the plant has great flexibility as to character of output. There is a surplus of billets and sheet bars for the open market, but this has been practically all sold for the balance of the year. The completion of the plant releases a large tonnage of crude steel.

which the Youngstown company had been receiving from the Republic Iron & Steel Co., but the advent of the new producer has been scarcely felt in the market. Never before has the starting of a new Bessemer plant made so little impression.

FINISHED MATERIALS.

Mills are sold up practically full for the remainder of this year, and well into next year, on plates and shapes. Some rail mills have their entire 1907 production sold, and others from a fourth to a half of their production. All the important producers of steel bars have contracted for substantially their entire output to the middle of 1907, and specifications thus far have been much beyond output. Sheets and tin plates, wire products and pipe have been sold on an average until nearly the close of the year. Booking has been heavy during August, but attended with no excitement. In some quarters advances are expected in sheets, tin plates and wire products.

The following prices are f. o. b. Pittsburg, plus regular freight to destination, and are regular mill prices on carload and larger lots to large buyers for forward delivery:

Beams and channels, 15 inches and under, $1.70 per 100 pounds; tees, $1.75; beams and channels over 15 inch, $1.80.

Plates, tank quality, ¼ inch and heavier, to 100 inches wide, $1.60.

Sheets, 28 gauge, box annealed, one pass cold rolled, $2.50.

Galvanized sheets, 28 gauge, $3.55.

Plain wire, $1.70.

Wire nails, $1.85.

Tin plates, 100-pound cokes, $3.75 per box.

Artifical Soft Graphite.

From Niagara Falls comes the important announcement that Mr. E. G. Acheson has succeeded in devising a method of making soft graphite in the electric furnace. The process is stated to be simple and cheap.

The artificial graphite, made up to the present by the International Acheson Graphite Co., has been hard graphite, and has found a large field of usefulness of its own, especially for electric furnace electrodes, electrolytic-cell electrodes, as a paint pigment, etc. The possibility of making also soft graphite in the electric furnace opens to artificial graphite a vastly greater field of applications, and is expected to make it a very serious competitor of natural graphite, especially since the artificial product is of greatest uniformity.

Artifical Diamonds.

Some time ago we referred to the presidential address of R. THRELFALL before the Birmingham section of the (British) Institution of Electrical Engineers on "some problems of electro and electrothermal chemistry." One of the subjects discussed in his address and not yet alluded to in these columns is the production of artificial diamonds or, what is the same, the artificial crystallization of carbon.

The artificial production of diamonds presents many problems of great interest. As is well known, Moissan succeeded in producing minute diamonds by saturating iron and other metals with carbon at electric furnace temperatures, and then suddenly cooling the molten mass by dropping the crucible and its contents into water, mercury or melted lead. These experiments have been followed up by Mayorana and others, ending with Sir William Crookes, who produces some evidence of the formation of microscopic diamonds by the explosion of cordite in a closed vessel.

By far the most important investigation hitherto published on this subject is that of Dr. A. Ludwig in the *Zeitschrift für Elecktrochemie*, Vol. VII., p. 273 (May 8, 1902), and in several patents; *e. g.*, British 16,908 and 17,119 of 1900, and 5482 of 1902. Dr. Ludwig has made a brave but unsuccessful attempt to produce diamonds, or rather cubic carbon, on the large scale.

The apparatus consists of compression vessels and compression pumps, enabling carbon to be kept under high pressure. The carbon was heated electrically in compressed hydrogen, and it was found necessary to cool the product of the operation very suddenly; this was accomplished by injecting water at enormous pressure, so that the carbon under investigation was struck by jets of water moving at immense velocities. The result of a successful experiment was to produce a sort of carbon glass, for obviously the rapid cooling does not afford time for the formation of crystals of appreciable size, and the glass tended to resemble black diamond rather than clear cubic crystals. Dr. Ludwig does not state how much of this material was obtained, so that it is not possible to form an opinion as to whether the process has any commercial interest. There can, however, be no question as to the interest and importance of some of the facts disclosed, and as this work does not seem to have received the notice to which it is entitled, Mr. Threlfall gives a summary of some of the experiments.

First in regard to the heating. At a hydrogen pressure of 1,500 atmospheres it was found impossible to form an arc between carbon terminals, even at 70 volts p.d.; while with metal electrodes the formation of an arc required practically no pressure at all, so that heat could not be developed conveniently in this way. According to the old experiments of Dulong and Petit, the cooling effect of different gases depends on the pressure in such a way that the effect is proportional to the pressure raised to the 0.45 power for air and the 0.38 power for hydrogen. These experiments of Dulong and Petit were only made at comparatively low temperatures, and may have been superseded, but it is probably safe to assume that the cooling effect of a gas (particularly hydrogen) does not increase very rapidly with the pressure, so that to produce a state of high pressure by means of hydrogen does not seem an unreasonable proposal, nor does it seem likely that we are to ascribe the non-formation of an arc in hydrogen to excessive cooling.

By placing two carbon rods in contact and in series with a source of current at the hydrogen pressure mentioned (1,500 atmosphere = 9.84 tons per square inch), Ludwig encountered a very instructive phenomenon. The current flowed for a few seconds and then stopped; after a few seconds more it rose again—again to fall to zero. The alternations continue indefinitely so long as the rods are kept in contact. The points of contact are found to have been converted into graphite at the close of the experiment. This is a unique experience, and most probably we may accept Ludwig's explanation as correct, viz.: that the first result is to transform the heated carbon into a solid or liquid non-conducting variety. This cuts off the current, and after a few seconds is itself transformed into graphite as the temperature falls; this enables contact to be re-established and the cycle recurs.

Unfortunately, Dr. Ludwig does not give any data as to the temperature at which this or other phenomena take place, and excuses this omission on the ground of the undoubtedly great, but not invincible, difficulty of making such temperature determinations. It is, nevertheless, stated that the melting point of carbon falls rapidly with rising pressure, and that the non-conducting variety was stable down to a red heat when "under pressure"—presumably about 1,500 atmospheres. The current density necessary to convert carbon into the non-conducting variety varies between 14 and 18 amps. per square millimeter sectional area according to the pressure. If a small rod of carbon or a pair of carbon points is heated in an atmosphere of hydrogen at 3,000 atmospheres pressure and allowed to cool, it is found that the resulting graphite does not differ from that formed at 1,500 atmospheres. All attempts to cool the transformed carbon by a jet of hydrogen compressed to 2,600 atmospheres, and blowing into the pressure vessel (at presumably 1,500 atmospheres) did not result in the formation of diamond, though in this case the graphite crystals were of "regular"

form, and one of them measured 5 mm. at its greatest length. Suddenly discharging the hydrogen from the pressure vessel so as to drop the pressure as quickly as possible only resulted in the formation of graphite.

The most successful attempt was made at a pressure of about 1,200 atmospheres, a carbon rod being arranged in the pressure vessel for resistance heating, and was provided with a lagging of some refractory non-conducting substance. The current is gradually raised till the interruption occurs, and this is allowed to take place two or three times. If no cooling is applied, soft. pure graphite results. If, on the other hand, water at 2,000 to 3,000 atmospheres is squirted in, a product consisting of carbon in non-conducting transparent form is obtained, but Dr. Ludwig does not give the yield.

A fair inference from this work is that carbon can be converted "into the non-conducting variety" at pressures not necessarily exceeding the moderate amount of 1,200 atmospheres, and at temperatures which are known to be quite easily attainable by resistance heating. The difficulty consists in preventing the reconversion into graphite as the temperature or pressure falls—the most rapid cooling attainable apparently only operating successfully on very small fragments of material.

Mr. Threlfall then adds some theoretical considerations of his own which are very interesting and suggestive, though they are essentially based on analogies, not fully proven. He gives the equilibrium diagram of octahedral and monoclinic sulphur, with the pressure in atmospheres and the temperature in degrees C. as coördinates (see, for instance, Van't Hoff's Lectures on Theoretical and Physical Chemistry, translated by Lehfeldt, Vol. I., p. 27). On the basis of certain analogies he then takes this sulphur diagram and writes "diamond" for octahedral sulphur and "graphite" for monoclinic sulphur. This method enables him then, of course, to draw theoretical conclusions as to the possibility of producing artificial diamonds.

He also points out that it should be possible to make vessels which will withstand a pressure of 50 tons per square inch for long-continued pressure, while 75 tons per square inch is given as the practical maximum pressure, if we put the working vessel inside another vessel, also under high pressure; 50 tons per square inch is 7,500 atmospheres—more than double Ludwig's highest pressure; and according to Sir William Crookes, Sir Andrew Noble has reached a pressure of 95 tons per square inch for a fraction of a second. There is, therefore, obviously room and opportunity for an extension of Dr. Ludwig's work by any one who has sufficient time and money at his disposal.

CORRESPONDENCE.

Kryptol.

To the Editor of Electrochemical and Metallurgical Industry:

Sir:—On page 296 of your August issue, Mr. Richard Seligman calls attention to the matter of the alleged composition of "kryptol." His results are almost identical with our own, although the specimens used for analysis were purchased in different countries.

We are also permitted to say that Mr. Bronn maintains in a private communication to these laboratories, that during the period of his management of the Kryptol Gesselschaft, *"only the purest carbon* was used in connection with the apparatus for high temperatures." This statement is published in justice to Mr. Bronn.

In view of the facts, as disclosed in the several communications that have appeared in your columns, it seems pertinent to repeat our inquiry as to where "kryptol" of the complex composition claimed may be had?

P. McN. Bennie.
FitzGerald & Bennie Laboratories.

Niagara Falls, N. Y.

Detinning.

To the Editor of Electrochemical and Metallurgical Industry:

Sir:—On page 325 of your August issue is printed a description of the detinning process disclosed in United States Patent No. 822,115, granted to Goldschmidt and Weber, with comments thereon.

The claims in this patent cover unimportant modifications of the process of removing tin from tin scrap by a solution of chlorine in an anhydrous liquid, as broadly covered by United States Patent No. 783,725, dated Feb. 28, 1905, granted to Mr. F. von Kugelgen and myself.

The only novelty claimed for the Goldschmidt-Weber disclosure appears to be the compressing of the tin scrap and the variation of pressure inside the detinning vessel, neither of which details properly constitute invention.

It may be interesting to know that, in company with Mr. Chas. E. Acker, we have formed the Tin Products Co., a corporation of the State of New York, for the purpose of exploiting our process above referred to.

George O. Seward,
Holcomb's Rock, Va. *Virginia Electrolytic Co.*

Fluxes in the Cupola.

To the Editor of Electrochemical and Metallurgical Industry:

Sir:—With reference to the paper of Mr. N. W. Shed, read at the Cleveland convention of the American Foundrymen's Association, and abstracted on page 332 of your August issue, we wish to make some remarks. Mr. Shed takes a very strong line against the use of fluorspar as a flux, and it is to this we wish to take exception.

In the first place, fluorspar as a flux, not only in cupola practice, but generally, is much more valuable than limestone. It has the power of liquefying the silicious and gangue minerals to a remarkable extent, to a very much greater extent than limestone, and on that account its use in metallurgy is very rapidly increasing. The production of our mines is now over 50,000 tons per annum, and is steadily increasing.

In the second place, a large number of the founders in this country admit that they do find a reduction of sulphur contents in the iron when fluorspar is used. Its action on sulphur is also borne out by the fact of its extensive use in the basic open-hearth furnace for the elimination of sulphur in the basic steel process.

As to the improvement, or otherwise of iron when fluorspar is used in the cupola, we have evidence of a large number of the best founders in this country that they do find the iron improved. Fluorspar undoubtedly assists in eliminating slag, the slag is thinned, and the metal is kept hotter, consequently sharper castings will be the result. In addition to this the charge in the cupola is brought down more rapidly by the use of fluorspar.

As to the contention that limestone is far cheaper than fluorspar, this, of course, goes without saying, but it should be made clear that the intention is not to use fluorspar alone as a flux, or as a substitute for limestone, but that the fluorspar should be used in conjunction with the limestone, the usual mixture being about 20 pounds per ton of iron melted.

It will be obvious, therefore, as the percentage of fluorspar used is so small, the additional cost of using it is exceedingly trifling, and is far more than outweighed by the many advantages obtained by using the spar, and also probably by the saving in fuel, due to the iron coming down more rapidly.

In conclusion, we cannot do better than refer to the very able papers and articles that have been read and written by Mr. F. S. Grinder, who has pretty conclusively proved the many advantages to be derived by using fluorspar in the cupola. Geo. G. Blackwell, Sons & Co.

Liverpool, England.

A Metallurgical Revolution in Guanajuato.

By Joseph W. Richards.

One hundred years ago the largest city on the American continent was not New York, it was the City of Mexico, New York was not even the second largest, while third on the list

FIG. 1.—THE HACIENDA DE PURISMA, NEAR MARFIL, GUANAJUATO.

was the mountain city of *Guanajuato,* the most picturesque, historic and interesting city in the Mexican Republic. The Spaniards found a town here in 1534, but in 1548 commenced the wonderful mining development, when two Spanish muleteers discovered the silver mines of La Luz. Since then, by methods which extracted probably only about 50 per cent of the value of the ores, some fifteen hundred millions of dollars of gold and silver have been obtained from these contorted mountains.

Historically, this is the birthplace of Mexican independence. Near here was born the patriot priest Hidalgo, who on Sept. 15, 1810, proclaimed the independence of Mexico, which was finally achieved after eleven years of struggle, during which, however, poor Hidalgo lost his life, and the hook is still shown, on the castle walls, where his head hung for years as a warning to the patriots.

Scenically, the city resembles a town of the hill country of Judea, let us say Jerusalem or Bethlehem. With square, flat-roofed houses, tinted with most of the colors of the rainbow, spreading along several miles of narrow valley and straggling up the steep sides of the mountains, with church towers, plazas and old castello making a Damascus-like *ensemble,* the effect on the visitor is altogether one of striking and absorbing interest.

With but one tortuous principal street, like Mauch Chunk in the Switzerland of Pennsylvania, and mule cars for transit, one is struck dumb with surprise to be confronted, at a sudden turn of the road, with the beautiful Juarez Theater, which cost half a million dollars in gold, and which is architecturally the most beautiful one on the American continent. The city, now counting 40,000 inhabitants, is a strange medley of the old and the new, of the antique and the most modern.

Geologically, the lower parts of the valleys are filled with barren conglomerate of a rich red color, which washes halfway up the sides of the mountains. The latter project through the conglomerate in light colored masses of rhyolite, like a peon's towering straw tile above his enveloping red blanket. The Veta Madre, or mother vein, is plainly traceable across the country for miles, being punctuated by the piles of debris extracted from the workings.

Mineralogically, the vein material is quartz, calcite, with hematite, arsenopyrite, pyrite, some pyrolusite and alabandite (MnS). Gold occurs metallic, both free and enclosed in the pyrites. Silver occurs as argentite (Ag^2S), proustite (Ag^3S^3As), and stephanite (Ag^5SbS^4). Average mine assays show $20 to $40 per ton, while tailings left on the mine dumps show $5 to $10, of which millions of tons are available for cheap treatment.

Metallurgically, the process of the past has been the *patio* process. Scattered along the narrow gulch, from Marfil at its entrance up to the head of the valley above Guanajuato, are the old *haciendas,* each named after some patron saint, but nevertheless provided with moats, drawbridges, double-barred gates and loop-holed towers at the corners. Only one of these is now running, the *Hacienda de Purisma,* near to Marfil.

In this three-century-old metallurgical plant is to be seen the old patio process just as we have seen it pictured by Percy and Schnabel. The Chilean mill with two mules and three workmen, doing about one-third as much work as a Griffin mill with one-sixth an attendant; the seventy *arrastras,* turned by blindfolded mules, grinding each about half a ton of ore per day; the broad *patio,* covered with ore mud 15 inches deep, and churned by the ever-patient teams of each a dozen mules, in narrowing and enlarging circles, presided over by a giant peon with a wicked whip, the very impersonation of inquisitorial cruelty.

Besides these were the *lavadores,* or washing tubs, with queer old eighteenth century wooden cog-wheels; the mercury strainers and distilling apparatus, all as quaint as the pictures in Paracelsus' "Re Metallica." Such is the process which is passing away, together with the old methods of hand mining, packing of the ore on burros, and extraction of only half the precious metals in the ore after all.

FIG. 2.—RECEIVING AND SAMPLING FLOOR.

The Hon. Dwight Furness, American Consul at Guanajuato, is the personification of United States enterprise, and during his sixteen years residence there has probably done more for the development of this camp than any other one individual. In an address before the Saturday Night Club of Guanajuato, published in the July number of the *Pan-American Magazine,*

he summarized so ably and completely the present metallurgical situation, and described so clearly the metallurgical revolution now taking place, from the patio to the cyanide process, that we cannot do better than extract freely from his address:

"Up to a recent date mining in Guanajuato was carried on under rather difficult conditions. Except for hoisting purposes, machinery was very little used, and even when so used, was very costly, owing to the lack of skilled mechanics and the high cost of fuel and repairs. The excessive cost of lumber

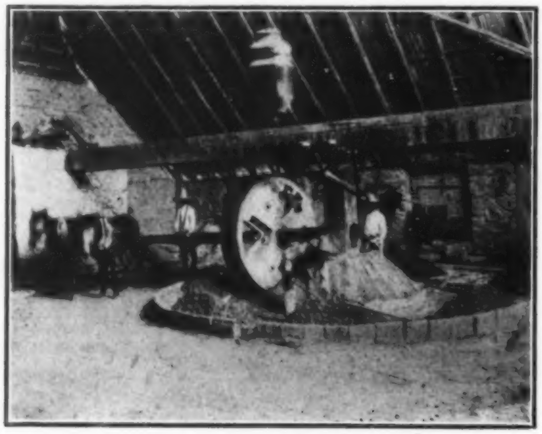

FIG. 8.—THE CHILEAN MILL.

made the timbering of the big circular rock shafts prohibitive, and, therefore, the larger mines used cable guides and hoisted water in galvanized iron buckets, fitted to the cable with ear guides, while the ore was handled in hide sacks, or 'mantas.' In the smaller mines the horse whims, or 'malacates,' were found cheap and nearly as efficient as the steam hoists, both ore and water being hoisted in hide bags without guides. Except when mining out the bonanza ore-chutes, practically all the ore was dumped on the 'patio' on the surface, and handsorted at a cost varying from $1.50 to $3.00 per ton. The ore from the stopes was carried on men's backs to the shafts and dumped and rehandled there. Barring the richer bonanza pay streaks, the mining of the ore cost from $15.00 to $18.00 per metric ton. Careful revision of the pay rolls of a number of the leading mines shows that a mine producing an average of 300 tons of ore per week was exceptional, and a mine of this capacity usually had a pay roll of from $4,000 to $5,000 per week. Even in the mines worked during the past ten years, and under comparatively modern conditions, like the Esperanza and Cedro, the cost of mining averaged over $12.00 per ton of ore sold to the mills.

"The mining by the 'patio' process was very efficient in the recovery of silver and equally deficient in gold recovery. There is no question but what a saving of 90 per cent of the silver was usual, while the gold saving varied from 30 to 40 per cent only from the mother-lode, and from 50 to 60 per cent from the mines like Peregrina and La Luz, from which the gold was more easily amalgamated. The cost of treatment varied greatly, being influenced chiefly by the price of quicksilver; the loss of quicksilver rapidly increasing with the grade of the mineral. The cost of treatment, therefore, varied from $12.00 to $17.00 per metric ton. The mills were nearly all located along the Guanajuato River, partly on account of water supply, and partly for reasons of security, causing a heavy freight charge on the ores from the mines to the mills, never less than $1.50 per ton, and often reaching $3.50 per ton.

"I remember seeing a very interesting table compiled by Engineer Pablo Orozco, then in charge of the Rul Estate mines. The Concordia Co. had been working the Mellado and Rayas mines for ten years, and had charged up against the mines a shortage, or loss, of nearly $500,000. This loss, however, was less than the amount of freight paid on the shipments of ore from these mines to the mills during the same period. The mines were almost universally worked under the old 'avio' or lease, and all profits, except in time of bonanza, were made in the mills, and in the course of time the mines were looked upon merely as feeders to supply ore to the mills, and worked for that purpose as economically as possible, so that the future of the mines and the exploration work for opening new ore bodies was greatly neglected.

"Free coinage of gold and silver obtained, the price fixed at the mint per kilo of silver was $40,915, from which were deducted Federal and State taxes, leaving net value paid to the mill owner by the mint of $37.68 per kilo. The assaying and melting charges reduced this to about $37.50 per kilo, which was the valuation universally used by the mill owners as net value of their silver. After deducting a treatment charge equivalent to from 500 to 600 grams of silver from the assay, the standard price paid by the mills on the remainder was at the rate of $29.80 per kilo. The gold in the ore was considered of little importance. The assay was made in grains per mark of silver. The average assay on the Veta Madre ores was about 20 grains per mark, of which ten grains for a so-called 'parting charge' were first deducted, in this case equivalent to 50 per cent of assay, the balance being paid for at the rate of 1¼ cents per grain, equal to about $8.00 Mexican currency per Troy ounce.

"The mint figured the gold at $675,416 per kilo, which, after deducting Federal and State taxes, was equivalent to 64.3 cents Mexican gold currency per gram of gold. There was an additional parting charge of $1.25 per kilo gross weight of bullion, making it impossible to part the gold unless assaying over 1½ one-thousandths fine in the bullion, while on the average gold fineness of the 'arrastro' bullion—20 to 30 thousandths—the cost of parting was about 5 cents per gram of gold. The mint paid for the gold with Mexican gold coin, which did not circulate, but was shipped out of the country, remelted and refined, these costs amounting to a little over 3 cents per gram Mexican currency on original gold value. The exchange rate during the greatest activity in the Guanajuato mines was at

FIG. 4.—AN ARRASTRA.

par, but up to recent years ranged from 30 to 40 per cent premium. This made the net value of the gold recovered a little less than 90 cents Mexican currency per gram.

"Taking the foregoing net gold and silver values in bullion and using the most favorable mining and treatment costs at hand, viz.: $12.00 per ton for mining, or a total of $26.00 per ton, the average grade of ore minted and milled shows results as follows: (All figures are in Mexican currency.)

800 grs. Ag 90" equals 720 grs. at $37.50 equals..	$27.00
5 grs. Au 40 per cent equals 2 grs. at $0.90 equals.	1.80
Total recovery	$28.80

Mining	$12.00	
Milling	12.00	
Freight	2.00	
		$26.00
Net profit per metric ton		$2.80

"Under the foregoing conditions the decadence of mining in Guanajuato is readily understood.

"During the past three years a wonderful transformation has taken place. First, a shrewd, level-headed lawyer from Colorado Springs visited the camp on legal business for some clients. The proverbial—and in this case we might say Providential—slowness of legal matters in Mexico left him with ample leisure. He cast his eyes over the brown bare hills, denuded long since of fuel, over the vast dumps and masonry walls, ruins of a glorious industry in a mining camp that held the world's record. He stepped aside in the streets to let pass the long trains of mules conveying in a crude way the ores from mines to mills, and he visited the 'patio' mills and found dozens of men and hundreds of mules treating the ores in a most laborious and primitive fashion. Looking on these things he was convinced that if great things could be accomplished under such conditions, even greater things could be accomplished by modern methods, and he had the courage of his convictions.

FIG. 5.—THE PATIO—GENERAL VIEW.

"Cheap power he rightly conceived to be the first essential, and he found at hand two hustling, shrewd young men, with more brains than capital, and through them, at a hundred miles away, the power was found. We old-timers smiled indulgently. We had seen a dozen American companies try to revolutionize Guanajuato methods and miserably fail. We signed contracts for the power because it didn't cost anything to sign them and couldn't do any harm. The first electric shock came a year later. The power was here and clamoring for payment, and only one company ready to use it.

"In the meanwhile, one of our pioneer American operators had been struggling along with one of the big old mines of the Veta Madre. He had developed large bodies of low-grade ores, but their values were absorbed by costly and inefficient milling processes. Then began a long series of costly experiments, which indicated that the Guanajuato silver ores could be successfully treated by the cyanide process, something heretofore not deemed possible. But capital is timid and wants something more than the work in laboratory or experimental plant, and not until this persevering and courageous man built a 150-ton per day cyanide plant—the first of its kind in Mexico—and demonstrated on this large working scale the absolute practicability of this process, were the doubters and scoffers finally convinced. To-day all the companies are erecting these plants.

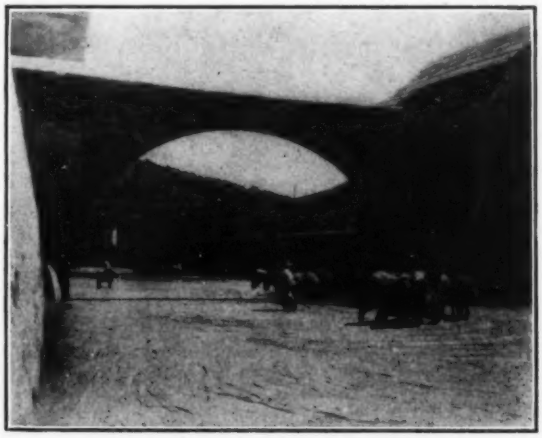

FIG. 6.—THE PATIO—NEARER VIEW.

"The next important stage of development was the placing of the mills in close proximity of the mines, avoiding all freight charges on the ores, and at the same time opening up and equipping the mines with mechanical contrivances for the rapid and cheap handling of large tonnage. The result of these changes is comprehensively shown by the following figures, taking the same assay values used in our first table, silver at 61½ cents, U. S. currency, per ounce and exchange at 200:

FIG. 7.—THE ARRASTRA MILL.

800 grs. silver 85 per cent equals 680 grs. at $37.50 equals		$25.50
5 grs. gold 90 per cent equals 4.5 grs. at $1.25 equals		5.62
		$31.12
Cost of mining	$4.50	
Cost of milling	4.00	
Administration	0.50	
		$9.00
Profit		$22.12

as against $2.80 under the old conditions. These recoveries of gold and silver, as well as costs of mining and treatment, are considered as average costs for the whole district, and are conservative. They are already bettered in several mines and mills, and no doubt some especially favorable ores will show a saving of 90 per cent of the silver and 95 per cent of the gold. Mining and milling costs will also in some cases be reduced to as low as $7.00 Mexican currency per ton. It requires no great effort to grasp the significance of these figures, but it does require a lively imagination to awake to the possibilities they convey.

"Nine dollars Mexican currency per ton from the mine's deepest workings to the bullion market. This means that ores assaying only 300 grams of silver can be mined and milled at a small profit; that ores containing only 10 grams of gold leave a profit of over $2; that Veta Madre ore assaying 400 grams silver and 2 grams gold leave a profit of $6 per ton. Recent developments in the larger mines seem to make it clear that nothing less than this value need ever be mined, and the indications are that the values saved in the larger mills will be fully $20.00 Mexican currency per ton.

"The awakening is already at hand. At the beginning of the year a careful tabulation showed that the approximate monthly

FIG. 8.—THE RETORTING PLANT.

expenditures of the mining companies of this district were only $80,000. By the close of the present year it will be over $200,000, and estimating only the additional projected work, it will, by the end of the year 1906, reach a total of $400,000 monthly.

"Another comparison: On Jan. 1, 1905, there were only ninety stamps dropping, and inclusive of 'patio' mills the total milling capacity was only 300 tons of ore per day.

"At the close of 1905 there will be 200 stamps with a capacity of 600 tons per day—over 200.000 tons per year, producing a gross value of $20 per ton, equal to $4,000,000 per year. The next year's developments promise to be far more startling. Counting only the mills in course of erection, those already ordered and those whose erection during the coming year are practically assured, we have a total of nearly 700 stamps, a capacity of 2,000 tons per day, or 700,000 tons of ore per year, and to which corresponds a gross production of $14,000,000, with a net profit of at least $5,000,000 yearly. This production is one-half more than was produced in Guanajuato in her most

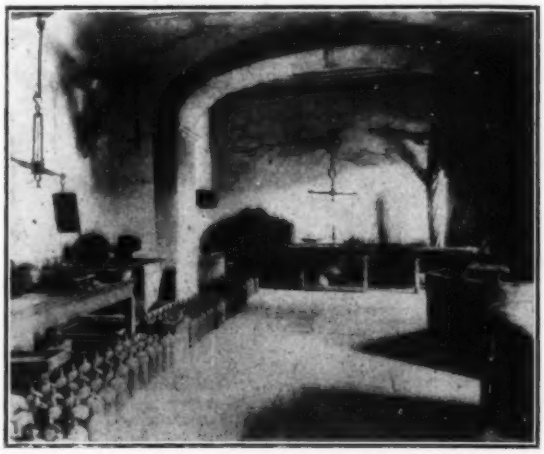

FIG. 9.—THE AMALGAM ROOM.

flourishing bonanza days. In the above figures I have not included the mining districts of Pozos. San Felipe or San Anton de las Minas—all important camps of this State and of great promise.

"But this is not all. Nothing succeeds like success, and capital rushes in when the pioneers have scored their first victories. The probabilities of the succeeding years are bewildering. It is certainly safe to say that the production for 1908 will be 50 per cent greater than that of 1907, and this on the low-grade ores only, which were until recently considered waste."

Manufacture of Carborundum in Europe.

For quite some time past the Carborundum Co., of Niagara Falls, intended to erect a plant in Continental Europe, to meet more directly the rapid increase in the demand of carborundum for grinding purposes in Europe. The European plant will now become a reality, the works being expected to open with the beginning of next year.

The official name of the German company will be the Deutsche Carborundum Werke, Ges. mit beschr. Haftpflicht. The plant will be located at Duesseldorf, in Rhineland, Germany. The engineers of the American company are to supervise the erection of the German plant, which will be equipped with the most up-to-date machinery for the production of abrasives.

While the Carborundum Co. of this country has been represented in the past in the principal cities of Germany, Great Britain, Denmark, Sweden, Norway and Russia, with stores in Berlin and London, it is evident that the completion of the German works will enable the company to push their European business with much greater energy.

The splendid success of the Carborundum Co., of Niagara Falls—evidenced by the rapid increase of the works—is well known to our readers. An illustrated description of the works as they were in 1902 may be found in our October issue of 1902. According to Mr. J. H. Pratt, of the United States Geological Survey, the production of carborundum in 1905 amounted to 5,596.000 pounds, the value varying from 7 to 10 cents per pound. Besides the very extended use of carborundum for abrasive purpose, it is now also finding very great favor for furnace linings in various cases.

JOINT MEETING OF THE IRON AND STEEL INSTITUTE, AND THE AMERICAN INSTITUTE OF MINING ENGINEERS.

The joint meeting of the Iron and Steel Institute and of the American Institute of Mining Engineers was held in London from July 23 to 28. Over fifty members of the American Institute, including the president, Mr. Robert Hunt, and the secretary, Dr. R. W. Raymond, attended the meeting.

Some notes on the proceedings of the first session on July 24 will be found in the regular monthly letter of our London correspondent on another page of this issue. It may be added here that at the suggestion of President Hadfield, of the Iron and Steel Institute, the following cablegram was sent to Mr. John Fritz, in Bethlehem: "This great and memorable gathering of Englishmen and Americans, united, send you, Bessemer Medallist and Honorary Member of the Iron and Steel Institute, heartiest and most friendly greetings. We congratulate you upon the immense progress in metallurgy made during your life time, and in which you have played so honorable a part. Long may you be spared to us."

Mr. Hadfield announced that Sir Hugh Bell had been elected to succeed him as president of the Iron and Steel Institute on his retirement next year. The three papers presented during the first session dealt with large blast furnace gas engines. Abstracts will be found below.

The second session, on July 25, was devoted to a general meeting of the American Institute of Mining Engineers. Mr. Hunt delivered his presidential address on the development of steel rail mills in the United States. He also announced that Mr. John Edward Stead and Mr. R. A. Hadfield had been elected honorary members of the American Institute of Mining Engineers.

Then followed a long discussion, introduced by Mr. A. L. Colby, on "a comparison of American and foreign rail specifications, with a proposed standard specification to cover American rails rolled for export."

In the session of July 26 a paper by Mr. J. P. Roe on his mechanical puddling process, and a paper by Mr. J. E. York on improvements in rolling iron and steel, giving a description of the York universal rolling mill, were presented.

The afternoons were devoted to numerous excursions. At noon on July 27 the King received a deputation from the Iron and Steel Institute and from the American Institute of Mining Engineers at Buckingham Palace. The American Institute was represented by Captain Hunt, Dr. Raymond and Messrs. Dwight, Fackenthal, Hartshorne, Kirchhoff, Oberlin, Smith and Ward. Mr. Hadfield presented the Americans, and asked the King, on behalf of the Iron and Steel Institute, to receive the Bessemer gold medal (which had also been held by the late Queen).

After the conclusion of the London meeting the American visitors made a tour through England, and visited the Rhineland-Westphalia iron district on the invitation of the Society of German Iron Masters.

In the following we give concise abstracts of all papers which had been printed in advance, from advance copies kindly sent to us from the secretary of the Iron and Steel Institute:

Dry Blast.

A paper by Mr. J. E. Johnson, Jr. (Longdale, Va.), discussed "different modes of blast refrigeration and their power requirements." The object of the author is to give data for determining the plant cost and operating cost of the blast-refrigerating apparatus under any given conditions, and to point out means whereby this refrigeration may be accomplished with less first cost and less working expenses per cubic foot of blast treated than were required by Mr. Gayley's installation.

Some parts of Mr. Johnson's paper are highly theoretical, but the following abstract is restricted to his general argument and his practical conclusions, and when necessary his mathematical analysis shall be translated into metallurgical argument. The standard temperature at which blast is measured is taken by the author as 70° F., at which 1000 cubic feet of air weigh 75 pounds, therefore all calculations are based on 75 pounds of air.

First, the "direct-expansion" system is compared with the "brine-circulation system." In the former the ammonia is expanded in the coils over which the air passes, in the latter the ammonia is expanded in coils immersed in a tank of brine, which is afterwards circulated through coils in the refrigeration chamber. It is obvious that the brine-circulation system requires twice the expense of coils or pipe surface, and also requires twice the temperature-interval between the temperature of the expanding ammonia and that of the air required by the direct-expansion system, since the heat requires to be transmitted through the walls of two sets of pipes instead of one. This means that "the substitution of the direct-expansion for the brine-circulation system leads to important economies in first cost, in power required, and in attendance, not offset by any necessary advantage on the side of the brine-circulation system."

Further, let us assume certain data corresponding to frequent summer conditions, namely, a temperature of 85° F. and a dew-point of 70° F., a condenser temperature of 85° F., and let the air be refrigerated down to 25° F. It is plain that the air leaving the refrigerating chamber at a temperature of 25° F. may be used for cooling the incoming air, with a saving of power to the incoming air. Therefore, "the regenerative system leads to important economies in first cost, only in minor degree offset by a loss of advantage to the blowing engine."

Now, concerning the refrigeration itself. Of all the moisture contained in the air at 70° F., half is precipitated when the temperature is lowered to 50° F., and of that removable down to 25° F. almost two-thirds. Yet the heat of all this is removed at the temperature of 25° F., if the one-stage refrigeration method is used. "This is precisely as if, in pumping from a shaft 45 feet deep, we put one pump at the bottom and let all the water run down to that level before pumping it out. It is really much worse than this, because in pumping heat the power required increases much faster than the heat, while with water this is not so."

"The remedy is as obvious in refrigeration as it is in pumping, to have two pumps catch the greater part of the heat near the top of its scale and pump it out from there, pumping from the lower level only the heat which comes in at or near that level, a much smaller quantity. This means the use of two ammonia compressor cylinders, one working from the 15° F. suction temperature as before, the other working from a much higher suction temperature, say, 36° F., both, of course, working to the same condenser temperature." This two-stage method of refrigeration leads to important economies in first cost, in power requirements, and in absence of trouble with ice on the coils of the first stage, not offset by any disadvantage worth considering.

By a combination of these methods (direct-expansion, double-stage, regenerative system), as compared with the brine-circulation, single-stage, non-regenerative system, the author concludes that it is possible to dry the blast with less than half the first cost of plant, with much less attendance and with one-third the power.

Finally, as to the minimum temperature, the author thinks

that from a commercial point of view there is no gain in refrigerating the air to too low a temperature. In summer, all the uniformity possible will be reached by refrigerating to 32° F., and all trouble from ice formation will be avoided by not going below this point. As the weather becomes colder and the dew-point falls so as to be sometimes below this point, the diminished refrigeration required and the lower temperature of cooling water available, will enable the same plant to maintain a lower temperature, and still retain the uniformity desired by reducing the temperature of the air below the lowest natural dew-point probable. This change being entirely under control of the manager will lead to no sudden changes, and will give a coke consumption in summer so nearly the same as that in winter that the difference will probably be inappreciable. As between a refrigeration temperature of 32° F. and one of 22° F., with a blast temperature of 1000° F. and normal coke practice, the saving for the latter will be about 2 per cent.

ELECTRIC INDUCTION FURNACE.

A paper by E. C. IBBOTSON (Sheffield) dealt with the Kjellin electric steel furnace, which has already been the subject of numerous articles in this journal.

At Gysinge, in Sweden, during the year ending May 31, 1906, from a fixed furnace giving 1 ton (2240 pounds) of steel per tap, there were produced 950 tons of tool steel and special steel ingots.

In carbon and iron tool steels all the usual tempers were made. The bulk of this steel was made from charges composed of about 80 per cent of Swedish pig iron and 20 per cent of steel scrap. The percentage of carbon was regulated by the addition of briquettes. Other charges were made from Swedish white iron and steel scrap.

The average time taken per charge, for the year, when adding briquettes, was 7⅛ hours, and the electrical energy consumed was 1,128 kw-hours per ton. The average time per charge for white iron and scrap charges was 5½ hours, and the electrical energy consumed was 886 kw-hours per ton. These consumptions include all time and energy lost from various causes, such as bad water supply, ice, etc.

It is quite ordinary practice to complete the charges with briquettes in 6½ hours, and without briquettes in 5 hours, as shown by the following typical charges:

White pig iron, 1,457 pounds; steel scrap, 439 pounds; briquettes, 220 pounds; ferro-silicon (50 per cent Si), 17 pounds; ferro-manganese (80 per cent Mn), 15 pounds; aluminium, 1 ounce.

The times, strength of current and energy consumed for this charge were as follows:

Time.	*Kw.*	*Kw-hours.*	
5.30	125	....	Charging two-thirds of the pig iron.
6.00	145	67.50	
6.30	160	76.25	
7.00	170	82.50	Charging the remaining one-third of the pig and the scrap.
7.30	170	85.00	
8.00	165	83.75	Clear melted.
8.30	165	82.50	Briquettes added.
9.00	165	82.50	
9.30	165	82.50	Briquettes added.
10.00	165	82.50	
10.30	165	82.50	Briquettes added.
11.00	165	82.50	
11.30	165	82.50	
12.00	130	73.75	Ferro-silicon and ferro-manganese added. Tapped.
6½ h.	....	1046.25	

A second charge was made as follows:

Steel scrap, 1,372 pounds; white iron, 914 pounds; ferro-silicon, 4.5 pounds; ferro-manganese, 6.5 pounds; aluminium, 1 ounce.

The time was reduced, no briquettes being added. The results were as follows:

Time.	*Kw.*	*Kw-hours.*	
7.00	125	....	Charging all pig and one-half scrap.
7.30	145	67.50	
8.00	155	75.00	
8.30	160	78.75	Charging scrap.
9.00	165	81.25	
9.30	170	83.75	
10.00	165	83.75	Clear melted.
10.30	165	82.50	
11.00	165	82.50	
11.30	165	82.50	
12.00	135	75.50	Ferro-silicon and ferro-manganese added. Tapped.
5 h.	....	793.00	

The chemical composition of the materials charged and of the resulting steel were as follows:

White iron (Herräng): Total C. 4.00 per cent, Si 0.15, Mn 0.18, S 0.010, P 0.012.

Briquettes: Fe 59.0, S 0.010, P 0.006, SiO_2 11.00, CaO 2.50, Al_2O_3 0.50

Steel ingots: C 0.40 to 2.00, Si 0.12, Mn 0.34, S 0.012, P 0.014.

The lining of this furnace during the year was magnesite. When using briquettes the lining lasts, on an average, five weeks, and when charges are worked without briquettes the average life of the lining is seven weeks.

Various tests have been made of the steels produced in this furnace. During the year satisfactory results obtained in works practice have been reported, particularly in connection with the following steels: stamping dies, punches, cold chisels, screwing dies and taps, cutlery, drills and turning tools. The following special steels have also been produced: Tungsten

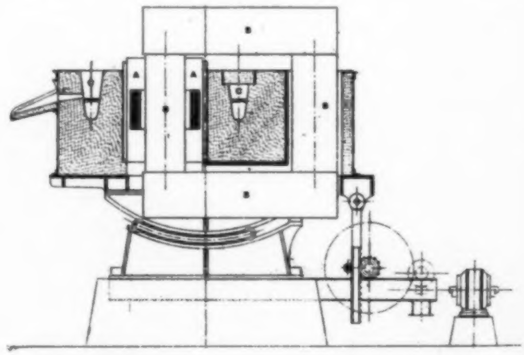

FIG. 1.—ELECTRIC INDUCTION FURNACE.

steel (including permanent magnet steel), chromium steel, nickel steel, nickel-chromium steel, self-hardening steel, and high-speed tool steel. High-speed tool steel, tested to one of the latest government specifications, gave satisfactory results, while 25 per cent unannealed 2-inch nickel steel bar, ½ inch in diameter, gave a yield point of 30.68 tons per square inch, a maximum stress of 50.44 tons per square inch, an elongation of 44.00 per cent, and a reduction of area of 60.00 per cent.

Electrical tests carried out have shown that No. 6 gauge rods had a specific resistance of 36 michroms per cubic inch; No. 16 gauge wire a specific resistance of 33.5 microhms per cubic inch.

The form of furnace adopted and recently erected is shown in Fig. 1. A is the primary coil, B iron coil, and C the bath

(secondary circuit). The advantages of this furnace are that it can be tipped over the lip, or from the tap-hole, and can easily be repaired and relined when necessary.

Silicon and Graphite in the Open-Hearth Process.

A paper by Alex. S. Thomas (Cardiff) discusses "the influence of silicon and graphite on the open-hearth process." The first part of the paper deals with a detailed discussion of the effects of using a high or low silicon pig. The author's experience is that when using pig with silicon of 2 per cent and over, the banks are seldom, if ever, fluxed, but that bad bottoms very often occur if the furnace man lags behind and does not add his oxides quickly enough to keep his slag from becoming viscous. When using pig with 1 per cent silicon or less, the banks are invariably fluxed, but the bottom of the furnace very seldom comes up. Therefore, in the acid open-hearth process a middle course must be steered by using an iron with the silicon neither very high nor yet very low, and the author's experience is that a silicon content from 1.25 to 2 per cent is an ideal one for the acid open-hearth melter.

There is no doubt that the up-to-date iron manufacturer is handicapped when making high silicon iron (above 1¼ per cent), and the acid steel maker is also handicapped when using iron under 1.25 per cent. To bring the steel maker into line with the iron maker, the author suggests that in furnaces making acid steel with low silicon iron, the acid bottoms now used should be replaced by basic bottoms, and the low silicon haematite iron worked on the basic bottom.

This could not be called a basic process, the essential aim and feature of the basic process (dephosphorization) being absent, and only enough lime (3 to 5 per cent) need be added to render the slag just sufficiently basic to prevent the banks and bottoms being fluxed. It would be an acid process on a basic bottom, and the quality of the resulting steel would be superior to the average quality made on acid bottoms. The output would also be increased 15 or 20 per cent, as so much more steel scrap could then be used in the charge.

The second part of Mr. Thomas' paper deals with the effect of carbon in the graphitic form, with special reference to the Talbot process. In a 160-ton furnace where haematite iron is used, silicon—contrary to one's expectation—is not a trouble to the same extent as graphite. In general, a high percentage of silicon in the iron is accompanied by a high percentage of graphite, so that high silicon is a disadvantage only because it is accompanied by a separation of the carbon in the graphitic form.

When a charge if iron containing a high percentage of graphite is worked, the whole bath in the furnace is covered with a layer of "kish," and sand shovels can be put into the furnace and the carbon actually ladled off the surface of the bath. When the iron is of this nature, the whole bath lies dormant until the carbon is partly burnt off and partly converted into the combined state. Further—whereas the average time taken in pouring a ladle of low-graphite iron into the furnace is only about 30 minutes—it takes 1½ to 2 hours to pour in an equal quantity of high graphitic iron. In this case no reaction takes place for some time, so that only 3 to 5 tons are poured in at a time. But when the reaction takes place, from 10 to 30 minutes afterwards, it is extremely sudden and violent. A few more tons of iron are then poured in, and usually another long wait ensues until the oxides and metalloids react. It is this waiting, interrupting the continuity of the process, lowering the output, and causing wear and tear of the furnace and a higher consumption of fuel, etc., which renders the presence of graphite objectionable.

Usually after emptying the ladle of high graphitic iron, the longest spell of inactivity takes place; this may last as long as 1 to 1½ hours before the bath begins to boil. The author has found that when iron with a high percentage of combined carbon was supplied, instead of highly graphitic iron, the output was immediately increased 25 per cent, and the wear and tear on the furnace was reduced 100 per cent.

"The foregoing applies to the effect of graphite when using molten iron. But does not the same condition of affairs exist in the ordinary process of charging cold material? When using pig iron containing a high percentage of silicon, is not the longer time taken in working such a charge—generally attributed to the high percentage of silicon—really due to the high percentage of graphite present? Why do some charges, using equal quantities of iron, with the same percentages of silicon, and practically the same percentages of total carbon, take so much longer to decarburize than others, under similar working conditions of heat, etc.? During the period of melting the percentage of carbon when in the combined form is greatly reduced by being partly oxidized in the oxidizing atmosphere in the furnace, but when carbon is present mostly in the graphitic state, this reduction does not take place, as the carbon is being converted into the combined form, so that when the charge is melted a greater percentage of carbon is present to be decarburized by the oxides added. When using high graphitic iron, the author finds that less than 10 per cent of the estimated carbon contents are eliminated during the melting period. This differs greatly from the 30 to 45 per cent given by Harbord and Campbell in their books."

Treatment of Fine Ores.

A paper by Albert Ladd Colby (New York City) discusses "the nodulizing and desulphurization of fine iron ores and pyrites cinder." The author describes a process which has been in operation continuously since the Summer of 1905, and has successfully and economically converted over 24,000 tons of fine ferruginous ores and by-products into "nodules," which have been smelted in blast furnaces without the difficulties accompanying the use of large proportions of fine materials, and has, furthermore, economically reduced the sulphur present in objectionable quantities in the fine materials.

The invention consists mainly in purifying finely divided metalliferous materials, and forming them into nodules or lumps, by adding to the materials a binder, preferably reducing

FIG. 2.—UNLOADING AT NEWARK PLANT.

in character, adhesive at low temperatures (approximately below 600° F.), and volatile at fairly moderate temperatures (approximately 1,200° F.), which binder has an affinity for, and is capable of forming volatile compounds with such impurities as sulphur, arsenic, etc.

In practice, any adhesive hydrocarbon or carbohydrate compound, such as tar, pitch, asphalt, petroleum residuums, dextrine, molasses, glucose, etc., may be used, provided it can be made liquid or plastic at comparatively low temperatures and can be readily and cheaply obtained.

The adhesive binder drops, or is sprayed, constantly into

the stream of fine ferruginous material as it enters the upper end of an inclined rotary kiln; the material is therefore at once cohered into masses, which by the rotary action break up into nodules or lumps. One per cent or less of an adhesive binder, such as tar, is sufficient.

When the lumps reach a zone of higher temperature the tar combines with the sulphur and both are volatilized, the binder acting as a fuel as well. When the nodules approach the lower and hottest end of the kiln (approximately 2,000° F.) incipient fusion takes place, so that the product is a nodule, permanently cohered without the presence of any extraneous binder reducing the percentage of iron or other valuable

FIG. 3.—UNLOADING AT NEWARK PLANT.

metallic constituents contained in the original fine material.

The process has already been successfully applied to a variety of fine materials fusing between a wide range of temperature, such as pyrites cinder, crude magnetite, magnetic concentrates, haematites (Mesaba), blast furnace flue dust, and franklinite (an iron-manganese-zinc ore).

The patents are now owned by the National Metallurgic Co. of New Jersey, which has erected a large plant at Newark, N. J. Other plants, using the process, are located at Aspinwall, near Pittsburg, Pa., at Steelton, Pa., at Hazard, Pa., and at Oxford, Pa. All these plants are described in the paper.

Several economic devices installed in these plants are, on account of their ingenuity, worthy of notice.

The appliances for the handling of the pyrites cinder, fine ores or coal, whether delivered to the Newark plant by water or by rail, are shown by Figs. 2 and 3.

At the Newark plant, dry bituminous coal is burned with a forced draught, the flame or flames entering the lower or discharge end of the kiln. Among the factors which cheapen

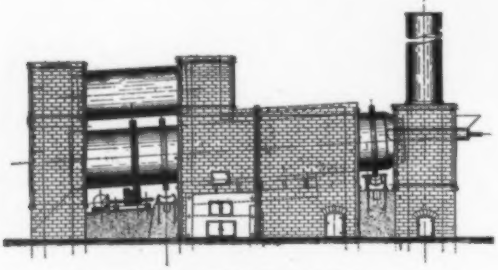

FIG. 4.—COAL-DRYER PLANT.

the use of the pulverized coal is a coal dryer of special design and an automatic speeder and screw conveyor, with the accompanying storage bin for the dry pulverized coal, shown in Figs. 4 and 5.

With these devices the coal is used economically; an automatic and accurate record of the coal consumption is kept, and a perfect combustion maintained between the wide ranges of kiln temperatures used in nodulizing different materials.

At the Pittsburg plant natural gas will be used; in the plants

FIG. 5.—AUTOMATIC DEVICES AT NEWARK PLANT.

erecting, or in contemplation, other fuels, solid, liquid or gaseous, may be found more economical.

An automatic plunger feed, shown in Fig. 6, of very simple construction ensures a steady delivery, into the kiln, of any desired amount per hour of the material to be nodulized, independent of its fineness, ore the amount of moisture it may contain. Uniformity in desulphurization can be thus assured by changing the rate of feed and the quantity of tar entering the kiln, when using materials containing different sulphur percentages, and also by regulating the speed at which the kiln is revolved.

The storage tank, of 150-ton capacity, into which the hot nodules are delivered from the kiln by a link belt conveyor, is so arranged that the large steel trucks can be filled from the

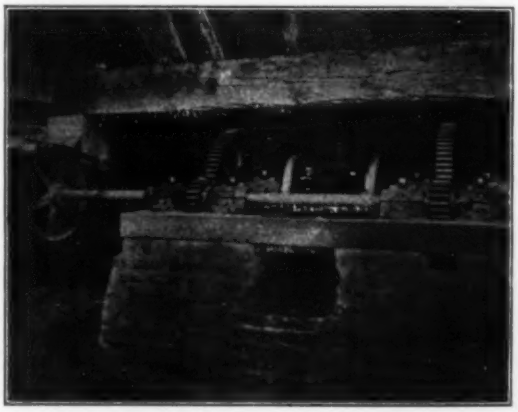

FIG. 6.—AUTOMATIC DEVICES AT NEWARK PLANT.

tank by the operation of a single lever, and if for any reason they are not at hand, the nodules, after the storage tank is full, are delivered on stock by an overhead shoot, into which the same link belt conveyor can also discharge. This is shown in Fig. 7.

The general construction of the kilns used in nodulizing may be seen by Fig. 8, representing kiln No. 3 of the Newark plant blocked up, and ready to be put in position.

During the development of the mines, supplying the Newark plant, it became evident that the pyrites, as shipped, would contain copper in paying quantities. The addition to the Newark plant of a modernized Henderson copper-leaching

plant was therefore decided upon. The most interesting feature of this plant is the adoption of the rotary kiln for the roasting of the ground mixture of copper pyrites, cinder and salt. This, it is expected, will prove a great economy over the styles of furnaces formerly used, for the kiln and its accessories are automatic in their operation, and the labor, especially in handling and rabbling the mixture, is greatly reduced.

The mixture will be handled by a belt conveyor from the grinding mills to the storage tank, from which, by a bucket elevator, it is fed automatically through a screw feed into the kiln.

Eventually the moist ore, free from copper, will be transferred by the overhead bucket crane to small tipping wagons that will be emptied into the storage tank, from which it will be delivered to the nodulizing kiln by the automatic plunger feed device, receiving its proper portion of tar as it enters the kiln.

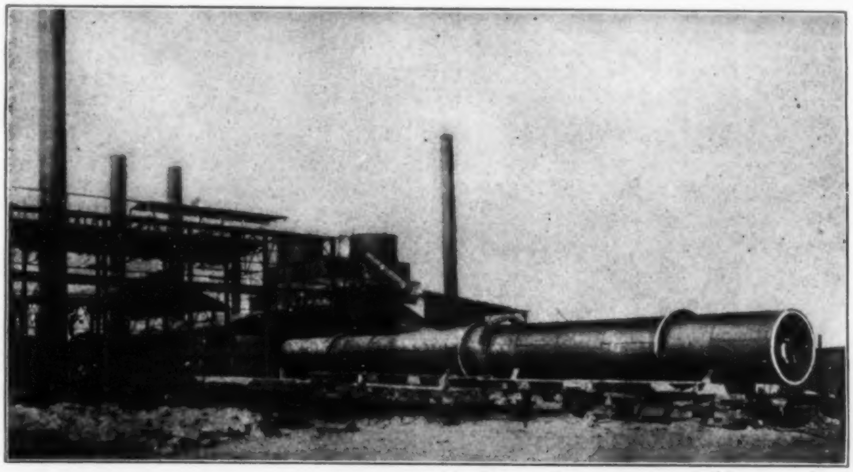

FIG. 8.—CONSTRUCTION OF NODULIZING KILN.

Copper pyrites cinder, containing as low as 1.50 per cent of copper, can be handled with a profit in this modernized Henderson plant.,

MECHANICAL PUDDLING PROCESS.

A paper by JAMES P. ROE (Pottstown, Pa.) discourses the development of the Roe puddling process. The paper begins with a concise description of the ordinary puddling process; the author emphasizes that the arduous character of the work in puddling and its consequent high cost suggest the introduction of mechanical means. The author also felt that mechanical means should be associated with large units and the use of metal direct from the blast furnace; that is, that the same broad means that have made possible the low costs in the modern production of steel should be utilized as far as possible.

The author decided that the best means of agitation would be that of simply flowing by gravitation in a long, inclined

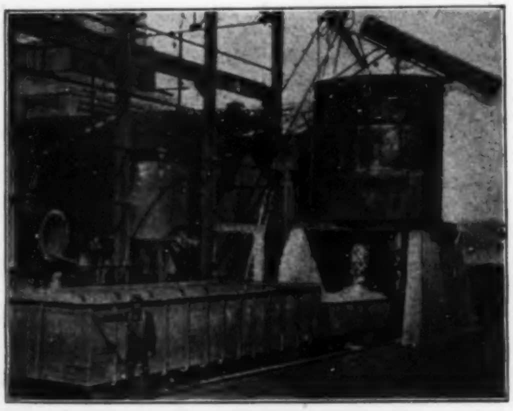

FIG. 7.—STORAGE TANK.

trough, but this idea was impracticable on account of the unreasonably great length which would have been required. The author then modified this idea by providing a trough of considerable length (but less than before), down which the bath could flow, first in one direction and then in the other. This possesses all the advantages of the long, fixed trough, together with the additional one of a sudden arrest at each end, by which the bath is forced through itself, and greatly increased thoroughness of mixture is obtained. This arrangement also utilizes the retardation of the lower stratum of the iron by friction on the bottom, producing the effect of waves running up a beach, while at the same time correcting it before it becomes excessive. In the first construction the trough was made 28 feet long.

Two long girders formed the sub-structure, upon which all the moving parts rested, and were suspended from two hollow trunnions, placed opposite each other at the middle of the length. The flames from two stationary coal fire-chambers passed through the trunnions into the furnace and out of the stacks at each end. The trough, forming the bottom, was made of steel plates, and was double, water passing through it to preserve the covering.

It was found necessary to modify this construction in various details, but the net result of this first series of experiments was that they proved conclusively that iron (coming in many heats directly from the blast furnace) could be puddled by causing a mixed bath of molten metal and slag to flow backwards and forwards in a heated trough, when the bath was arrested with sufficient suddenness at the end of each oscillation, and that the puddled iron could be massed into a compact ball by continuing this operation, and could then be shot out ready for further manipulation.

In deciding the question how to dispose of the puddle ball after it was made, the author concluded that in order to carry out the idea of using large units, the mass must be maintained in its integrity up to the point that is reached in modern steel practice, that is, up to the slab or billet. The puddling machine, therefore, must have the capacity to produce a ball which would approximate the weight of a steel ingot. The ball must be squeezed in one mass, rolled on a blooming mill and cut to lengths in slabs or billets. When this was accomplished the low costs of the modern steel plant should be attainable.

The path marked out, therefore, was the use of molten metal from the blast furnace and mixer, puddling in a machine to be further developed in detail, squeezing in a machine to be designed, and rolling in a blooming mill to slabs or billets, or, in a plate mill, directly to plates. By this means, there would be at least avoided the greater cost of handling loose piles of puddle bar. It will be noted that the course of procedure above noted is precisely that of steel making, mechanical puddling and squeezing being substituted for converting and casting into ingots.

The new machine, shown in prospective view in Fig. 9, has the side plates of the trough extended downwards, to form two

semi-circular racks, which gear into pinions on a countershaft. The four stacks are so placed as to produce as even a distribution of the flame and temperature in the furnace as possible. The door, forming the whole of one end, is operated by means of an hydraulic cylinder, placed horizontally under the furnace. The door is firmly locked by means of wedges, which pass through the side plates and are actuated by two small hydraulic cylinders. The sill and lintel of the door are water-cooled in order to chill the molten cinder when it strikes them, and thus to seal rapidly the joint and prevent the egress of iron.

The trunnions carry the whole weight of the machine, and are supported on roller bearings. The machine itself is so balanced that it has a slight tendency to always return to a

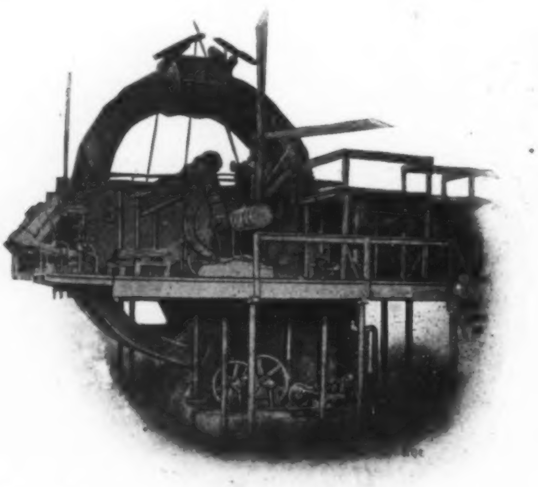

FIG. 9.—MECHANICAL PUDDLING MACHINE.

horizontal position. As a consequence, although the machine is heavy, but little power is required to operate it. The heating agents are admitted through the trunnions. In the present case the author uses oil as fuel.

The molten iron and cinder are brought to the machine in ladles, and are raised on a hoist, from which they pour directly into the machine near the end opposite to the door. There are seven observation holes, through one of which, near the door, the oxidizing agents are charged by means of a long spoon reaching across the furnace. There is also a tapping hole in the rear end, which is used for bleeding, if desired.

The machine is intended to move through an arc of 140°, and the 4,000-pound ball strikes the ends with considerable violence. The bricks, as well as everything else, had to be so secured as to meet these trying conditions of strain and shock in addition to the ordinary strains due to heat.

Coincident with the building of the new machine, a squeezer was built, operated by hydraulic power, applied by cylinders acting in three directions.

One of the important features in the Roe puddling process is the abandonment of all fettling, and the charging of all cinder and oxidizing agents. An auxiliary furnace for melting the cinder was, therefore, a necessary addition to the plant.

The author describes at length the troubles which he had to overcome in his work and which were mainly due to the use of part of an old Bessemer plant. Considerable trouble was also experienced with the design and construction of the working bottom, which were changed repeatedly.

The most important feature is the production and maintenance of the proper cinder, both chemically and physically. The conditions being the same in this respect as in the ordinary puddling process, the same kind of cinder is required. It is produced and regulated practically in the same way, except that, since there is no fettling to act as an automatic regulator, the proper composition must be effected and maintained by direct additions. The cinder which is charged just before the melted iron consists generally of remelted puddle tap cinder, although iron ore or any other oxide of about the same composition acts equally well. It is not strongly oxidizing in its effect, but fulfils all the other functions of ordinary puddling cinder. The oxidation of the metalloids is brought about by the addition of roll scale or any other similarly pure oxide of iron. The proper composition and condition of the cinder is also controlled by the regulation of the flame, as in the ordinary process.

The dephosphorization is chiefly determined by the amount of silica present in the cinder. It was definitely settled that with 25 per cent of silica in the final cinder the dephosphorization was practically nil, while with 12 per cent of silica in the cinder the phosphorus was reduced to 0.06 per cent in the iron, regardless of the amount originally in the pig, provided that the phosphorus in the cinder did not amount to much over 5 per cent. The amount of phosphorus in the finished iron can, therefore, be controlled very closely. The thorough elimination of sulphur was also completely established, but it was not settled that it could be as easily and completely controlled as the phosphorus.

The experiments of the author demonstrated in a general way the entire technical and commercial practicability of the process: "It can safely be affirmed that" in a well-designed plant with continuous running the commercial costs "would not exceed those of a well-equipped steel works." The iron is more thoroughly worked than in the ordinary puddling process, and the metalloids can be more completely eliminated. This permits either of starting with inferior pig irons or the production of better material from the same grades, thus widely extending the range of material entering into the blast furnace or produced from it.

[There was a long discussion of the paper, opened by Dr. Raymond, who referred to the fact that in recent years iron is being again favored to a greater extent, owing to the smaller degree of corrosion, compared with steel. Mr. A. Sahlin, Mr. Joseph Hartshorne and Mr. B. Talbot had seen the process in operation, and bore testimony to its practicability. Mr. Talbot thought the greatest difficulty would be to get suitable iron; in order to get a regular proudct, a mixer was desirable. Prof. Banerman and Prof. T. Turner questioned whether it was desirable to produce a ball of such a size as is done by the author. A smaller mass might give better results.]

Machine Moulding Practice.

A paper by PH. BONVILLAIN (Paris) discusses "recent processes in machine moulding practice." After a historical introduction the author discusses present-day practice and describes in detail his designs of a set of universal moulding machinery, which adapts itself to almost all the requirements of foundry practice, no matter how intricate the castings to mould from it may be. The machine is essentially a combination of a moulding press and of a parting-off machine; *i. e.*, a machine to lift the finished mould from the pattern plate in a few seconds, without any special regard to the height of the casting.

High-Speed Steels.

Dr. H. C. H. CARPENTER presented a report on "tempering and cutting tests of high-speed steels," made in the (British) National Physical Laboratory with nine different steels.

The research was undertaken in order to ascertain whether the temperature at which high-speed steels soften can be pushed higher than 700° C. The only steel with which any success was reached was a sample which is not a recognized steel of this type. This alloy appears to resist softening by thermal influences even at 800° C., and if its behavior were judged from this standpoint only, better results might have been expected than have been actually obtained.

But it must be remembered that the tempering of such tools in practice is produced by a combination of mechanical stress and high temperature. The question has yet to be answered whether the influence of the former factor is direct or indirect. To the author it appears probable that its influence is indirect; *i. e.*, that the mechanical stress to which the tool is subjected in practice does not of itself tend to soften it, but rather the reverse, and that it is the heat generated by friction between the tool and the material it is cutting that is the main cause of tempering. The evidence at present available tends to show that mechanical work which is not accompanied by a great rise of temperature tends to *harden* metals and alloys.

However this may be, the author fully admits that further research in regard to the causes of the tempering of high-speed steels is necessary, and until these have been elucidated such steels will not reach their highest degree of efficiency in actual industrial practice.

Blast Furnace Gas Engines.

Three papers on this subject were presented, dealing with English, Belgian and German practice.

Tom Westgarth's (Middlesbrough) paper is entitled "Notes on large gas engines built in Great Britain and upon gas cleaning." He gives a list of gas engines of 500 hp. or more, built in England; there are six manufacturers of such sizes in England; the number of such engines actually built is 119, and their aggregate indicated horsepower 96,085, but it must be said that the author includes not only large gas engines, operated with blast furnaces gases, but also those supplied with producer gas. The latter are greatly in the majority. A few gas-cleaning apparatus are briefly described.

Prof. H. Hubert (Liège) discusses "the design of blast furnace gas engines in Belgium." The paper is essentially a historical review of the work of the Cockerill Co., with some notes on recent tests, made by the author, of the 1,400-hp. two-cylinder double-acting and tandem gas engine, installed in their electric service. The progress made during the last ten years by the Cockerill Co. is indicated by the following figures: In comparing the trials of 1906 with those of 1900, which gave results which were considered excellent at that time, there was found a diminution of 15 per cent of calories used per 1 hp. For the brake horsepower the reduction attains 31.4 per cent. Finally, the thermal efficiency came out as 15.77 per cent for an 8-hp. gas engine tested in 1896, as 25.2 per cent for a 600-hp. single-cylinder, single-acting, constant-admission engine, tested in 1900, and as 29.84 per cent for the 1,400-hp. engine, tested in 1906.

The advantage obtained, as compared with the employment of steam, is by no means the least interesting of facts brought out by this investigation. Admitting that a 70 per cent efficiency is obtained by burning the gases under boilers, which is considered satisfactory, and that the steam raised amounts, according to Carnot's cycle, to an efficiency of 40 per cent (between 200° and 10°, which the cycle of Rankine makes 77 per cent of that of Carnot), and finally that one could succeed in obtaining 80 per cent of the Rankine cycle, the thermal efficiency becomes 17.25 per cent, which is lower by 42 per cent than that of the 1,400-hp. gas engine mentioned above (29.84 per cent).

The author assumes that a blast furnace, producing 100 tons of pig iron per day, produces about 9,000 cubic meters of gas at 1,000 calories, available for the production of power. Under these conditions, by obtaining 2,450 hp. with the steam engine and 4,220 by using the gas direct in gas engines, there remains a difference of 1,770 hp. in favor of this new application over the results obtained by a first-class steam plant of the usual (boiler) type. "These figures explain the success obtained in metallurgy by the direct use of blast furnace gas."

The paper is concluded by a list of Cockerill blast furnace gas engines, "at work or building;" they number 55, and their aggregate horsepower is 53,505 i. h. p.; there are "additional orders" for nine more Cockerill gas engines aggregating 9,650 i. h. p., while 113 engines have been built by other companies, under licenses from the Cockerill Co., aggregating 103,550 hp.

A paper by K. Reinhardt (Dortmundt) on "the application of large gas engines in the German iron and steel industries," is quite voluminous and pretentious, covering 107 pages with numerous illustrations in the text and fifteen additional pages of drawings. It is impossible to give at this place more than an outline of the ground covered in the paper.

The first part of the paper gives exact information on the extent of the application of gas engines in iron works and collieries in Germany, on the basis of the answers received upon a systematic circular inquiry of the Society of German Ironmasters.

Of the forty-nine German smelting works questioned, thirty-two had in March, 1906, gas engines at work and nine had ordered such engines. The largest aggregate power of gas engines at a single works amounts to 35,000 effective horsepower, sixteen works possess over 10,000 hp., and twenty-seven works possess over 5,000 hp. in actual working.

In most German iron works the whole of the gas engines work continuously without any reserve; a few have up to 40 per cent reserve of gas engines, and a few have a similar reserve of older types of steam engines or steam turbines.

Nearly all engines in German iron works work with blast-furnace gases. Two plants use only coke-oven gases, three use blast-furnace gas and coke-oven gas separately, and one plant uses the two gases mixed. The Mansfield Co. utilizes the waste gases from the copper-smelting furnaces for driving gas engines. Producers employing coke as fuel are kept as a reserve at seven works. "They are really only of use in case of a strike, to assure the working of the most necessary part of the plant.

The application of gas engines in German collieries is much less important. This is due to the fact that the heat given off by the older type of coke oven can only be utilized under steam boilers, and, consequently, for these older plants, steam boilers are inevitable in collieries. Only the excess gas produced in the coke ovens is available, so that steam engines and gas engines will always be found in conjunction; and, indeed, in larger proportion as regards steam engines than is the case in iron works. In the new regenerative coke ovens the waste heat is utilized for preheating the oven itself, whereby there is an economy in gas, and a greater excess of gas is available for driving gas engines. In view of the irregular production of gas, however, the application for gas-engine driving can only be considered free from drawbacks when at least sixty coke ovens are in operation. The production of gas in coke ovens is much more irregular than in blast furnaces.

"Perhaps in the near future, in addition to the excess coke-oven gases used for driving motors in colleries, producer gas, which will be obtained in the ring producer patented by Bergrat Jahns (*Zeit. d. Ver. Deutsch. Ing.*, 1904, p. 311), may also be used. The chief object of this producer is the utilization of the waste heaps or culm banks, and the production of gas, as far as possible free from tar. The gas from the producer mentioned is naturally also suitable for the driving of gas engines, which is demonstrated by the gas-engine plant at the Von der Heydt mine. The same object is effected by the Turk and other producers; but so far as the writer is at present aware, the utilization of the waste heaps and of low-grade coal in gas producers is only just being introduced, so that, for gas engines in collieries, at present only coke-oven gas need be taken into consideration. So far as he is aware, in the beginning of March of this year, sixteen collieries possessed thirty-five gas engines at work, in course of erection or on order. The aggregate power of all these engines was 30,300 eff. h. p. Of these twenty-four engines were already working at 15,600 eff. h. p., nearly all for the production of electricity.

"The introduction of large gas engines in collieries was subsequent to their introduction into iron works, and, there-

fore, only engines of comparatively recent construction are to be found. Exception must, however, be made in respect to the smaller motors, which were early employed in plants for the recovery of the by-products in coke-oven gas."

The second part of Mr. Reinhardt's paper is entitled "practical experience obtained in working," and deals essentially with the methods of gas cleaning. This part will be dealt with in detail in our next issue.

The third part of the paper relates to "the present design of large gas engines in Germany." At the present time twenty-nine firms in Germany build large gas engines. Of these, twenty-one firms build double-acting four-cycle engines, five firms build two-cycle engines, and three firms build both systems.

The author first makes general remarks on details of construction of cylinder, exhaust-valve chest, valve gear, stuffing boxes, cooled pistons and piston rods, ignition and starting. The following modern types of German double-acting, four-cycle gas engines are then described and illustrated: Maschinenbau Gesellschaft, Nürnberg; Gasmotorenfabrik Deutz; Ehrhardt & Schmer, Schleisfmühle; Märkische Maschinenbau-Anstalt, Wetter-Ruhr; Elsässische Maschinenbau-Gesellschaft, Mühlhausen; Fr. Krupp Aktien Ges, Essen-Ruhr; Gutehoffnungshütte, Oberhausen; Schüchtermann & Kremer, Dortmund; Maschinenbau-Aktienges Union, Essen-Ruhr; Duisburger Maschinenbau-Aktienges, formerly Bechem & Keetman, Duisburg; Dingler'sche Maschinenfabrik A. G., Zweibrücken.

Of two-cycle engines the engines of the Oechelhaeuser system, constructed by the Aschersleben Maschinenbau A. G., and by A. Borsig, Berlin, and the Koerting engines, built by Koerting Bros. and their concessionaries are described

The question of two-cycle versus double-acting four-cycle engines is considered as an open question by the author. Up to March, 1906, German gas engines with 260,000-brake horsepower, were at work or on order for double-acting four-cycle, as against 91,000 for two-cycle. "If these figures prove that the competition of the two-cycle engine must not be neglected, on the other hand the importance and connection of the builders of the four-cycle types must be considered advantageous to the latter."

For driving high-speed dynamos, double-acting four-cycle engines are preferable. On the other hand, the two-cycle engine is, without any doubt, most suitable for driving blowing cylinders. The author thinks that theoretical discussions concerning the correct or the incorrect mechanical efficiency, which during the last year created such a stir in Germany, do not cut any figure in practice at present. The problems of security in working, in addition to its price, is all-important; and the quantity of gas consumed per brake-horsepower is the least important.

"Suitable trials concerning the consumption of gas in more recent engines are not available for comparison, therefore it is not known how far the two-cycle engine is at the present time, in this respect, still inferior to the four-cycle engine. Should the iron works now be compelled to consider an economy of gas, the author does not believe that the larger consumption of the two-cycle engines would for long have any great influence on the question of systems; for then the iron works would probably first consider a more thorough cleaning of the gas employed for heating the blast and for burning under the boilers, thereby increasing its value, and in this manner to save gas. So long as these conditions remain as they are, and so long as the four-cycle engine is not more secure, under average working conditions, than the two-cycle engine, so long will the question of systems not be decided by general and theoretical considerations, but in such cases by the iron works and mining industries themselves.

"The situation was well summed up by a manager who, referring to this very point, told me personally that he himself preferred double-acting four-cycle, but his engine drivers preferred double-acting two-cycle.

"As regards other industries, they need not at present be considered to such an extent that they could assist in deciding the question.

"In conclusion, it is my duty to state that the present position of the application of gas engines in German iron works shows the value the managers of these undertakings attribute to the better and less dangerous utilization of the waste gases of their furnaces, and the successful efforts that have been made by the German engineers in order to meet the requirements suddenly demanded by iron works. It also proves that German iron works are obliged to utilize to the uttermost the sources of power at their disposal, in order to ensure their existence and their participation in the trade of the markets of the world. In other richer countries, with more favorable conditions, the matter is not so urgent."

[An account of the extended discussion which followed the reading of these three papers may be found in the London letter from our special correspondent on another page of this issue.]

Constitution of Iron-Carbon Alloys.

In a paper on "the constitution of iron-carbon alloys," Dr. Albert Sanveur (Cambridge, Mass.) discusses the meaning of the various curves in the classical Roberts-Austen Roozeboom diagram.

The chief result of his considerations is as follows: Microscopical evidences show conclusively that four distinct constituents are formed during the cooling of steel, namely: (1) austenite, (2) martensite, (3) troostite, and (4) pearlite, and martensite, and especially troostite, may be regarded as transition constituents in the transformation of austenite into pearlite. On the other hand, by looking into the meaning of the thermal critical points of steel, it is found that four constituents must necessarily be formed during the cooling of steel, and that these must be respectively: (1) solid solution of carbon in gamma iron, (2) solid solution of carbon in beta iron, (3) solid solution of carbon in alpha iron, and (4) the iron-carbide eutectoid. Dr. Sanveur's conclusion is that these four constituents must be those revealed by microscopical examination, that is, respectively, austenite, martensite, troostite and pearlite.

Crystallography of Iron.

An extended paper by F. Osmond and G. Cartand (Paris) on the crystallography of iron cannot be briefly abstracted. The only positive conclusion which the authors draw from their experimental researches is, that the three allotropic varieties of iron, although they all crystallize in the cubic system, present well-marked specific characters, and cannot have the same internal structure.

After the conclusion of the London meeting and a trip through England, a large number of the party of the American Institute of Mining Engineers followed an invitation of the Society of German Ironmasters to visit the Rhenish-Westphalian iron district.

The party arrived on Aug. 13 in Duesseldorf, and visited on Aug. 14, after a trip down the Rhine, the Krupp works at Rheinhausen, in which practically all the work of the Krupp concern is centered, with the exception of the war material, which is made at the Essen works.

On Aug. 15 three different parties visited either the Haniel colliery on the Rhine, near Homberg, or the two large iron and steel works at Ruhrort (the Phœnix and the Rheinische Stahlwerke), or the Gutehoffnungshütte at Oberhausen.

On Aug. 16 an excursion was made to Remscheid, with a visit of the Héroult electric steel plant at the Lindenberg works, while on Aug. 17 a trip was made on the Rhine, which brought the official visit to an end in the most delightful manner. All the American visitors were full of praise for the German hospitality showered on them. Private excursions were made on the following days to the Differdingen works at Luxemburg, and to Hannover and the Hartz Mountains.

Factory Scale Experiments With Fused Electrolytes—III.

By Edgar A. Ashcroft.

In this, the last of the present series of articles, I shall describe a few, as yet untried processes of metal winning, the result of deductions and possibilities to which the formerly described work on lead and zinc, and the work with the sodium process described at the last meeting of the American Electrochemical Society, and printed in the June number of this journal, have led me.

The double electrolytic apparatus with magnetic stirring and circulation of the intermediate electrode has many such possibilities, and some of them at least should be a fruitful field for future experimenters to work in.

Thus, in the treatment of mixed ores, several processes suggest themselves. The diagram, Fig. 1, shows one such in which sulphide ore is electrolyzed directly into a bath of lead, all the metals being deposited by a current of high density, and the sulphur distilled off and collected.

In the second cell all the metals other than the precious metals and the metal which is employed as carrier (in most cases lead) are dissolved at the fluid anode and received fractionally upon a suitable cathode.

To render this possible without encountering too great electrical resistance and other difficulties, the author has devised a form of revolving cathode shown in Figs. 2 to 5. This apparatus is suitable for collection of metals either in solid or in liquid form. The action of the apparatus is as follows: A disc is supported on a vertical trunnion, the whole moving

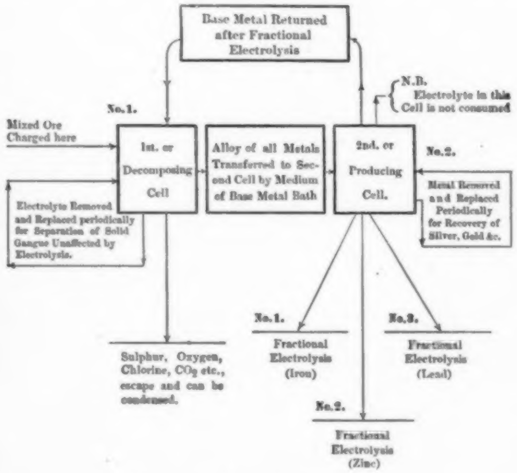

FIG. 1.—SCHEME OF TREATMENT.

system being balanced so that it floats upright in a pocket of fused metal. When the current passes, the radial of lines of force distributed along the disc cut lines of magnetic force produced by a coil carrying the main current and placed behind the lining of the cell (exactly as in the formerly described apparatus wherein the liquid cathode is made to revolve).

From the rectangular cutting of these two sets of lines mechanical motion of the disc results. The disc spins violently, throwing up a wall of fused metal all round the trunnion, which keeps it automatically in the center. When a solid metal is being collected the friction of the disc on the electrolyte also helps to ensure a good deposit, and it is only necessary to slip out the old disc and replace it by a new one when the deposit gets too heavy.

A continuous adjustment may be made for the slow increase of weight by an automatic device whereby the quantity of floating medium in the pocket is varied, in order to maintain the distance between the cathode and the anode constant.

When a liquid metal is being received at the cathode this is thrown off the periphery of the disc by centrifugal action, and may be collected in an annular groove, as shown in Fig. 3. Again, the motion of the disc may be used for forcing the metal

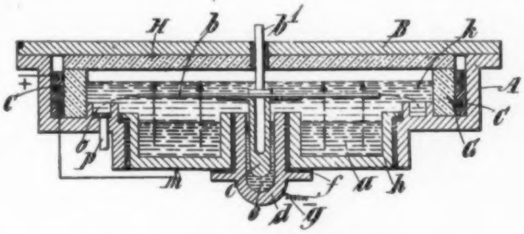

FIG. 2.—DETAILS OF REVOLVING CATHODE.

inwards along various arrangements of spiral grooves towards the center, when it may be drained off or ejected upwards by a screw pump device. The details of such devices will be self evident.

I should like to point out here that in all such devices the thermal efficiency of the apparatus, considered as a motor, is not only of minor importance on account of the relatively small energies we are dealing with, but it is absolutely unimportant to the net result, because in all such devices we are employing part of the electrical energy of the system as a heat producer anyhow (this is always the case in a minor degree even when the bath is heated externally), and any energy wasted in the motor system contributes directly to the heat of the bath. The objections which have been raised to this class of agitating device, therefore, do not stand at all on examination. The real questions which determine the value of such a device are durability and cheapness, both of first cost and of manipulation; in other words, convenience.

In this revolving solid cathode device (as in the case of the revolving fluid cathode) there is no kind of positive friction at all, the moving parts being in contact with fluid media, and so no destruction of parts due to friction results.

2. Very many modifications and possible applications of the revolving solid cathode device at once present themselves. Sodium deposited on such a cathode may be caused to collect in the center of the revolving disc in virtue of the centrifugal force, and thence be continuously or periodically removed by any convenient device. Magnesium might be similarly treated, and possibly aluminium, also, but of these metals I shall speak further. Iron and zinc can be separated by such means, and also lead from iron or lead from zinc. Zinc, lead or iron can be separated from copper, and it is for these four metals that I think the arrangement presents the greatest promise of commercial application.

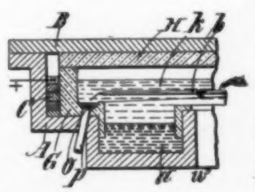

FIG. 3.—DETAILS OF REVOLVING CATHODE.

When any of the metals lower in the electropositive scale such as Au, Ag, Bi, etc., are present in the ore, these will accumulate in the lead or other metal employed as intermediate electrode, and may be for the most part readily separated out at suitable intervals. Gold and silver particularly may be readily removed from lead by cupeling. When antimony or arsenic are present they will be converted at once to chlorides in the first cell and will distill off. They may be readily collected for further treatment by condensers placed beyond the sulphur condensers.

In concluding this series of articles I am led to remark on the following points of interest to experimenters and investors, upon whose labor, enterprise, fortitude, wisdom and perse-

verance the future of our young industry depends. There is a very prevalent popular fallacy amongst the rank and file of engineers which greatly overestimates the importance and value of isolated new ideas. There is, also, especially in England, an equally exaggerated but conversely acting bias of mind towards conservatism and against all forms of experiment. Now, I think the true wisdom for the advancing industry of the future will be found half-way.

Ideas in themselves are as common as blackberries in a hedge row. Certain minds run to them naturally, and I have known men who could fill an encyclopædia with novel ideas in a year. Experiment of some kind also is absolutely necessary for every kind of industrial business. Many experiments, too. cannot be conducted on a small scale and be effective. But most people of any experience in such matters know how hard it is to draw the line between what is necessary research and what is mere desultory groping in the dark. Experiments, too, on a large enough scale to secure reliable results are always costly, and if indulged in too freely by any industry may easily be disastrous.

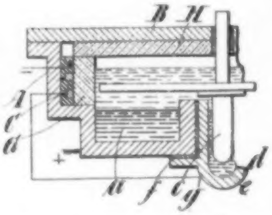

FIG. 4.—DETAILS OF REVOLVING CATHODE.

What is really needed to safely make the passage between the scylla and charybdis of ruin or stagnation is judgment; and judgment is a purely human and subjective quality, not (at present at least) reducible to a mathematical standard. Therefore, it arises that no kind of calculation or business precaution on known lines can securely protect capital from loss or secure the best fruition of labor.

The ultimate resource in such matters is the selection of the right man for the job, and giving him the best facilities and a reasonably free hand. The faculty of accurate selection of men is what secures the success of the industrial director before any other quality.

But even after all precautions have been taken it must be recognized that all progress is inherently dependent on some risk, for the less risk the man at the helm of technical affairs is willing to take on his shoulders. the less is his possibility of production, and especially of keeping abreast of the times.

Great difference in these respects are to be observed between certain national temperaments. Thus, whilst we can find much to admire in the great fertility of ideas and dash in execution, which is characteristic of the American people, who have accomplished so much even amidst wreck and disaster; we may also admire the slow-going qualities of our German contemporaries, who, like the tortoise in the race with the hare, make an excellent showing by perseverance and intelligent, patient application in spite of the slower pace they travel at. We may admire, too, much of the sturdy conservatism of the English manufacturers.

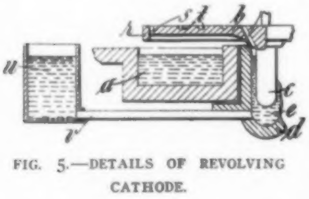

FIG. 5.—DETAILS OF REVOLVING CATHODE.

What we cannot admire is the obstinate and self-satisfied stupidity which is the true enemy to all progress, and though sometimes found in thoroughly prosperous communities is in reality only fattening on the labors of past generations, favored by accidental circumstances and contributing nothing at all to the sum of the world's work. The industrial progress of the future will be due to a blending and judicious selection of the best in all nations' characteristics, not to the exaggeration or exclusive triumph of any one. This cosmopolitan spirit is, I am glad to say, becoming the most general attitude of the technical workers and producers of to-day.

Metallurgical Calculations.

By J. W. RICHARDS, PH. D.

Professor of Metallurgy in Lehigh University.

THE RATIONALE OF HOT-BLAST AND DRY-BLAST

Problem 55 (for practice).

The blast furnace of Problem 54 (July number) had its blast dried before using, to the extent of leaving on an average 1.75 grains of moisture per cubic foot of air proper, at —5° C., in the air pumped. The composition of the ore, limestone and coke used was unchanged, also that of the pig iron made. The weights charged per 100 of pig iron were: Ore 177.6, flux 44.4, fuel 77.0, and the blast used calculates out oxygen 76.5, nitrogen 255.0, moisture 1.0. Analysis of gases: CO 19.9, CO^2 16, N^2 64.1 per cent. Product per day 447 tons. Temperature of gases 191° C., of blast 465° C. Piston displacement (air at — 5° C.) 34,000 cubic feet per minute. Assume heat in pig iron and slag same as before, in cooling water 20 per cent greater per day.

Required: (1) The volume of gases per 100 kg. of pig iron made.

Answer: Measured dry, 355.9 m^3.

(2) A balance sheet of materials entering and leaving the furnace, per 100 units of pig iron.

	Charges.	Pig Iron.	Slag.	Gases.
Ore 177.6	Fe^2O^3 135.7	Fe 95.0	....	O 40.7
	H^2O 17.8	......	....	H^2O 17.8
	SiO^2 17.8	Si 1.0	SiO^2 15.7	O 1.1
	Al^2O^3 6.3	......	Al^2O^3 6.3	....
Flux 44.4	SiO^2 2.2	......	SiO^2 2.2	....
	CaO 21.1	......	CaO 21.1	....
	MgO 2.1	......	MgO 2.1	....
	CO^2 .19.0	......	....	CO^2 19.0
Fuel 77.0	C 67.8	C 4.0	....	C 63.8
	SiO^2 4.2	......	SiO^2 4.2	....
	CaO 4.2	......	CaO 4.2	....
	H^2O 0.8	......	....	H^2O 0.8
Blast 332.5	O^2 76.5	......	....	O 76.5
	N^2 255.0	......	....	N 255.0
	H^2O 1.0	......	....	H 0.1
				O 0.9
	Totals 631.5	100.0	55.8	475.7

(3) The volume of blast per 100 kg. of pig iron.

Answer: 252.9 m^3 at —5° C.

(4) The efficiency of the blowing plant.

Answer: 82.3 per cent.

(5) The heat balance sheet of the furnace, per 100 of pig iron.

Developed.

Carbon to CO	92,950	Calories
Carbon to CO^2	206,955	"
Heat in hot blast	37,850	"
Solution of carbon in iron	2,820	"
Formation of slag	4,260	"
Total	344,835	"

Distributed.

Reduction of iron	165,870	"
Reduction of silicon	7,000	"
Expulsion of carbonic oxide (CO^2)	18,666	"
Evaporation of moisture of charges	11,342	"
Heat in waste gases	23,799	"

Decomposition of moisture of blast......	3,225	Calories
Heat in slag..............................	29,820	"
Heat in pig iron.........................	32,500	"
Heat in cooling water...................	14,922	"
Lost by radiation and conduction (diff.).	37,791	"
	344,835	"

(6) Compare the heat items which are substantially different for the furnace run by moist and dried blast.

	Moist Blast.	*Dried Blast.*
Combustion of C to CO..............	131,220	92,950
Heat in waste gases..................	43,836	23,799
Decomposing moisture in blast.......	14,511	3,225
Loss by radiation and conduction....	51,180	37,791

It may be noticed, that using moist blast too much carbon was burnt to CO at the tuyeres; the chief item of economy with dried blast is the ability to get along with less. The smaller total amount of gases, particularly nitrogen, accounts for the lower temperature of the waste gases, with dried blast. The direct saving by reason of decomposition of the moisture is the smallest item of economy. The reduced losses by radiation and conduction are mainly because of the faster rate of running, these losses being nearly constant per day. The ratio of these losses is found to be 0.74, whereas, the inverse ratio of the pig iron productions per day was 0.79.

(7) Calculate the carbon burnt at the tuyeres, the proportion of the carbon available thus consumed. Compare these items with those of the furnace on moist blast.

	Moist Blast. %	*Dried Blast.* %
Carbon burnt at tuyeres..............	75.3	58.05
Total fixed carbon charged............	84.3	67.8
Proportion burnt at tuyeres...........	89.3	85.6
Fixed carbon really available..........	79.4	62.9
Proportion burnt at tuyeres...........	94.8	92.3

(In some charcoal furnaces of low heat requirement, *i. e.*, with pure ores and fuel, as little as 37 parts of carbon is burned at the tuyeres per 100 of pig iron produced, which represents, moreover, only 70 to 75 per cent of the available fixed carbon in these furnaces.)

(8) The proportion of the whole heat requirement available in the region of the tuyeres.

Answer: **53** per cent.

(9) The proportion of the iron in the furnace which is reduced by solid carbon from FeO.

Answer: **23.8** per cent.

(10) The theoretical maximum of temperature at the tuyeres.

Answer: **1965°** C.

HOT BLAST.

For several centuries blast furnaces were run by charcoal as fuel and with cold blast. How great the variations in temperature of the cold blast may be, can be inferred from the experience of a furnace manager in the Urals, Russia, who noted temperatures of the air nearly 40° C. in the summer and —60° C. in the winter. Assuming an average temperature of 0° C. for unheated blast, burning charcoal to CO, the theoretical maximum of temperature before the tuyeres can be calculated as follows:

Heat generated by combustion	2430	Calories
Heat in hot carbon being burnt	0.5t — 120	"
Volume of CO and N^2 formed	5.3795	cubic meters

$$\text{Temperature} = \frac{2310 + 0.5t}{5.3944\,(0.303 + 0.000027t)}$$

Whence $t = 1678°$

This does not mean that the pig iron and slag will be carried to this temperature, any more than if a locomotive could run alone 90 miles an hour it could therefore pull a train of cars that fast. The hot gases, CO and N^2, are at the start at this temperature, and as they ascend and come in contact with the descending iron and slag, these are raised to temperatures approximating towards, but always lower than, the above. In fact, the temperature to which the iron and slag is raised depends on the relative quantities of iron and slag to fuel burnt, and the speed with which the furnace is worked.

If the blast is heated, its sensible heat is simply added to the numerator of the above expression. We can easily find out how much sensible heat the 4.4685 cubic meters of air brings in, at any temperature desired $[Q = 4.4685\,(0.303t + 0.000027t^2)]$, and then solve the quadratic anew. We thus find:

Temp. of Blast.	*Heat in Blast.*	*Theoretical Temp.*
0° C.	0 Calories	1678° C.
100° "	137 "	1762° "
200° "	276 "	1845° "
300° "	417 "	1929° "
400° "	561 "	2012° "
500° "	707 "	2096° "
600° "	856 "	2180° "
700° "	1007 "	2265° "
800° "	1160 "	2350° "
900° "	1316 "	2435° "
100° "	1475 "	2520° "

The heating of the blast thus raises the maximum temperature available some 68° C. for each 100° C. to which the blast is heated. It not only increases the temperature available, but also the number of heat units, thus increasing both the quantity and the intensity of the heating in the tuyere region. Of these two items of increase, that of the intensity factor is the most important, since it regulates the rapidity of transfer of heat to the charge and the efficiency and speed of the smelting action of the furnace.

DRIED BLAST.

Each kilogram of water vapor decomposed absorbs 29040 ÷ 9 = 3227 Calories, which would not be needed if the 0.67 kilo. of carbon thus employed was oxidized by air instead of by moisture. Per kilogram of carbon oxidized by water vapor, there is absorbed 58,080 ÷ 12 = 4,840 Calories, while this kilogram of carbon can only furnish 2430 Calories in becoming CO, leaving a net absorption of 2410 Calories per kilogram of carbon thus burned, against which, however, can be credited the heat in the kilo. of carbon burned and the sensible heat in the water vapor itself; the former is 0.5t — 120, and the latter can be calculated from the volume of the water vapor, 1.8519 cubic meters. We thus have, per kilogram of carbon thus oxidized:

Temperature of Water Vapor.	*Heat in Moisture.*	*Heat in Products.*
100°	66 Calories	0.5t — 2464 Calories
200°	137 "	0.5t — 2393 "
300°	214 "	0.5t — 2316 "
400°	296 "	0.5t — 2234 "
500°	384 "	0.5t — 2146 "
600°	478 "	0.5t — 2042 "
700°	577 "	0.5t — 1953 "
800°	682 "	0.5t — 1848 "
900°	792 "	0.5t — 1738 "
1000°	907 "	0.5t — 1623 "

Since the heat in the carbon burnt (0.5t — 120) can never equal numerically 1623, it is seen that under no circumstances can the water vapor do anything but diminish the quantity of heat available at the tuyeres, while the products of its decomposition CO and H^2 increase the volume of the products and so diminish still further the intensity of temperature attainable.

The best way to determine the amount of moisture in the air is to draw it through a tube containing concentrated sulphuric acid, measure the quantity of dry air drawn through, and weigh the amount of moisture caught by the tube. This gives the weight of moisture *accompanying* unit volume of dry air

(not weight of moisture in unit volume of moist air). Determinations by the wet and dry bulb thermometers, the whirled psychrometer, humidity gauges, etc., are none of them so reliable as the above described method, which is direct, simple and accurate. The results may be obtained in grains per cubic foot of dry air or milligrams per liter. The best way to express them, for further use, is in ounces avoirdupois per cubic foot, or kilograms per cubic meter. The first is obtained by dividing the number of grains by 437.5, the second by dividing the milligrams per liter by 1000. The numbers thus obtained are practically identical in the two systems.

The theoretical temperatures attainable with moist blast of varying degrees of moisture and heated to various temperatures are obtained by applying the previously explained principles. We have already calculated the temperature obtained by burning carbon with dry air of various temperatures. We have also calculated a table of the deficit of heat available produced by the entrance of 1.5 kilos. of water vapor (which would oxidize 1 kilo. of carbon and produce 1.8519 cubic meters of CO and H^2). We are, therefore, prepared to calculate a table of the maximum temperature attainable using blast of any degree of humidity heated to any practical temperature. Before giving the table we will run through the details of one calculation, to make clear the method employed.

Illustration: What is the theoretical maximum temperature using air which carries normally 10 grams of moisture per cubic meter of dry air, reduced to standard conditions (*i. e.*, 10 grams per 1.293 kilograms of dry air), and heated to 500° C.?

It takes 3.5275 cubic meters of dry air at standard conditions to burn 1 kilogram of carbon. If dry, and at 500°, there is 2430 Calories generated by combustion, 707 Calories in the dry air used, 0.5t — 120 Calories in the hot carbon, and the total heat thus at hand raises the 5.3944 cubic meters of products to the temperature of 2096° C., as is determined by solving the equation

$$t = \frac{2430 + 707 + (0.5t - 120)}{5.3944\,(0.303 + 0.000027t)} = 2096^\circ$$

As modified by the moisture, the 4.4685 cubic meters of dry air would be accompanied by 44.685 grams of moisture, or 0.044685 kg., which would oxidize two-thirds of its weight of carbon, or 0.02979 kg. of carbon, which would contribute to the heat available 0.02979 (0.5t — 2146) Calories, making a contribution of 0.015t — 64 Calories to the numerator of above equation. The products of combustion will be increased by H^2 and CO equal in volume to twice the volume of the moisture, or $2 \times 0.044685 \div 0.81 = 0.1102$ cubic meters, the mean specific heat of which goes into the denominator. We then have

$$t = \frac{3017 + 0.5t + 0.015t - 64}{(5.3944 + 0.1102)\,(0.303 + 0.000027t)} = 2030^\circ$$

Another method of solution, not using the previously calculated tables but based entirely on first principles, is to base the whole calculation on the use of 1 cubic meter of dry air, with its accompanying moisture, as follows:

Oxygen present in 1 m^3 dry air $= 1.293 \times 3/13$	$= 0.2984$ kg.
Oxygen present in the moisture $= 0.010 \times 8/9$	$= 0.0089$ "
Total	$= 0.3073$ "
Carbon consumed $= 0.3073 \times 0.75$	$= 0.2305$ "
Volume of moisture $= 0.010 \div 0.81$	$= 0.0123$ m^3
Volume of oxygen in dry air	$= 0.2078$ "
Volume of products from dry air $= 1.0000 + 0.2078$	$= 1.2078$ "
Volume of products from moisture $= 2 \times 0.0123$	$= 0.0246$ "
Total volume of products	$= 1.2324$ "

Heat of combustion of carbon $= 0.2305 \times 2430$	$=$ 560 Cal.
Heat in carbon at t° $= 0.2305 \times [0.5t - 120]$	$= 0.1152t - 28$ "
Heat in dry air at 500° $= 1 \times [0.303 + 0.000027\,(500)]\,500$	$=$ 158 "
Heat in moisture at 500° $= 0.0123\,[0.34 + 0.00015\,(500)]$	$=$ 3 "
Heat absorbed in decomposing moisture $= 0.0123 \times 2614$	$= -32$ "

Whence results the equation

$$t = \frac{0.1152t + 661}{1.2324\,(0.303 + 0.000027t)} = 2030^\circ$$

By applying either of the two methods of calculation expained, the temperatures in the following table are obtained:

THEORETICAL TEMPERATURES BEFORE THE TUYERES.

Moisture { Grams per cubic meter of dry air reduced to 0° C. / Grams per cubic foot of dry air reduced to 0° C.

Grams.	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00
Grains.	2.19	4.38	6.57	8.75	10.94	13.13	15.32	17.50
Blast.								
40°	1678°	1647°	1615°	1573°	1536°	1507°	1471°	1443°
100°	1723	1692	1666	1627	1587	1548	1526	1496
200°	1807	1776	1751	1712	1673	1636	1612	1584
300°	1892	1861	1837	1800	1760	1725	1700	1673
400°	1976	1945	1921	1885	1846	1813	1786	1760
500°	2061	2030	2007	1970	1933	1902	1874	1848
600°	2146	2115	2093	2055	2020	1991	1962	1936
700°	2232	2201	2178	2144	2108	2080	2050	2025
800°	2318	2287	2264	2227	2195	2169	2138	2114
900°	2404	2373	2351	2313	2282	2257	2226	2203
1000°	2490	2459	2437	2399	2369	2345	2314	2292

The calculations show that the temperature before the tuyeres may vary as much as 235° C. = 423° F., from change in the moisture of the air, from dryness to warm air saturated with moisture.

Notes on Electrochemistry and Metallurgy in Great Britain.

(*From Our Special Correspondent.*)

THE FARADAY SOCIETY MEETING.

The last meeting before the monthly vacation was held on what was new ground for the Faraday Society, namely, in the lecture theater of the Society of Arts, instead of in the library of the Institution of Electrical Engineers. The reason was the large audience which assembled to hear Prof. Birkeland's paper on the "Fixation of Atmospheric Nitrogen" (extracts from which were given on page 295 of our last issue). The chair was taken by Prof. Silvanus P. Thompson.

After the paper had been read in a slightly compressed form, Dr. Borns opened the discussion by asking whether the actual yield was not a mixture of nitrite and nitrate. As regards the temperature of working, the temperature of the arc was popularly supposed to be 3,500° C. In the electric fixation of nitrogen was there any maximum temperature for efficient working? The replies were given in each case to each speaker, so the author replied that he did not think that the temperature exceeded 3,500° C., owing to the quick diffusion, the incoming cold air limiting the temperature.

Mr. Hutton then praised the paper and congratulated Prof. Birkeland on his success. The advance over earlier systems was very marked, the magnetic deflection of the arc being a special feature. It was stated that variations in frequency and air flow did not occasion much variation in the yield. Were

the results sufficiently definite to afford exact differentiation? He would also like to ask a less discreet question, namely, what was the actual yield? Did the figure of 500 to 600 kilogrammes per kw-year refer to the arc, or did it include the driving of the arc blowers, losses in transmission and in deflection. Prof. Birkeland answered that the magnets only took 0.7 per cent. In the new 30,000-hp. installation only 1,000 hp. was used for all other purposes than feeding the arc. As to variations in yield, structural design seemed more important than frequency and air flow. For instance, if the fire-chamber was too narrow the diameter of the flame increased, and after a certain point the output fell off.

Dr. Perkins asked whether if the air was drawn through at too great a rate, would it not reduce the yield by cooling the flame? Also, did not a too narrow a chamber ensure a greater cooling effect and lower the efficiency? Prof. Birkeland replied that too great an air velocity extinguished the arc.

Prof. Walker raised the question as to whether 79 grammes per kw-hour might be taken as the maximum yield. The reply was in the negative, to the effect that this was not the highest output. That figure had been cited from a particular experiment. The highest figures had to be kept secret.

Dr. Steinhart, speaking from a practical standpoint, wanted to know whether the estimate of £4 per ton for the electrically produced calcium nitrate covered only the cost of electricity, labor and raw material, or did it include depreciation, etc.? Also what was the maximum specific gravity of the nitric acid obtained? In his own experiments 1.35 had been the best. In reply, Prof. Birkeland explained that the price quoted covered all expenses. It was possible to produce 50 per cent nitric acid, but the sole purpose of the Notodden factory was to produce calcium nitrate. The cost per kw-year might be taken at 15 kronen (18 kronen = $5 roughly).

Mr. Crooks asked about the life and construction of the copper electrodes. How was it they did not melt, and how was cooling effected? The reply consisted in the passing round among the audience of a hollow water-cooled copper electrode, which had stood 500 kw. for 300 hours.

The discussion was wound up by Prof. Silvanus P. Thompson, who spoke of his own visits to Notodden, and praised its industrial and scientific features. Notodden was a commercial factory and nothing else. At Arendal all the experimental work was carried out. Prof. Witt's investigation was most exhaustive and the result of 500 grammes per kw-year must be regarded as a minimum and not as a maximum yield. Nitrite was produced as well as nitrate but the latter was increased by a further oxidation of the nitrite in two receivers before passing to the scrubbers and towers. The cost of power was all important, and he could vouch for the fact that the cost per horse-power-year at a pulp factory at Svaelgfos was only 10 shillings. Dr. Borne had spoken of arc temperature. In the carbon arc the limit was that of the volatilization of carbon. In other arcs other limiting factors arose. Really the origin of Prof. Birkeland's work lay in his early investigations of the phenomena of the Aurora Borealis, and also in the shadow effect in the Crookes' tube as limited by a current carrying solenoid, and also in the fact that cathode rays varied in their susceptibility to the action of magnetic fields.

The second item on the agenda, in the shape of an interim report by Dr. Haanel, met with a very restricted treatment, owing to the lateness of the hour. Mr. Harbord read a brief laudatory extract, pointing out the fact that titaniferous ores could not be used in blast furnaces owing to the refractory nature of the slag. (The paper of Dr. Haanel is essentially identical with his last preliminary report to the Canadian Government, which has been fully covered in our July issue, p. 265.)

Dr. G. Senter's paper on the "Electrolysis of Dilute Solutions of Acids and Alkalies at Low Potentials; Dissolving of Platinum at the Anode by a Direct Current," was then taken as read, discussion being deferred until the first meeting of the Autumn session.

Purification of Drinking Water with Hypochlorites.

A paper, read by Dr. S. Rideal and Mr. Ronald Orchard at the Bristol Congress of the Royal Sanitary Institute, "On the Prevention of the Growth of Algae in Water Supplies," contains an account of some exhaustive laboratory experiments with electrolytic hypochlorite solutions. The paper commences with a discussion of the value and objections (largely sentimental, in the opinion of the authors) of copper sulphate treatment. In regard to this they point out that the actual cost of the material is insignificant, the chief outlay being incurred in connection with labor, storage and the systematic testing of the product for freedom from copper. They advocate the use of electrolytic chlorine in the hypochlorite form, as even if such treated water was distributed with its full amount of "available chlorine" it would not be harmful in the high dilution employed. However, the removal of the chlorine is rapid and very certain, so that the only permanent addition to the water is a minute quantity of common salt.

For their experiments the authors used a solution obtained from a hypochlorite plant of Mr. W. Pollard Digby's invention. This solution, besides having the advantage of cheapness, contains but little undecomposed sodium chloride, and consequently the final additional of chloride to the treated water is very small.

In considering the treatment of water with electrolytic chlorine, first of all the immediate chlorine consumed figure must be determined, that is to say, the "available chlorine" at once taken up by the organic matter of the water, since obviously in order to successfully inhibit growth the addition of the chlorine should be equal to or in excess of this amount, although in one of our experiments an addition of only half the average Cl immediately consumed (0.17 parts per million), decidedly retarded growth in tap water.

Briefly, the conclusions arrived at from a lengthy series of experiments were:

1. Green growth can be entirely prevented by the use of electrolytic chlorine. 2. The different microscopic plants decidedly require varying amounts of chlorine to inhibit their development, confervæ appearing to be most susceptible to treatment. "Available chlorine" just in excess of that immediately consumed by the water, although disappearing itself in a few hours, inhibited conforvoid growth for some weeks. Desmids were found to be slightly more resistant, and in the experiments, required the addition of some 0.5 parts per million in excess of that immediately consumed by the water. Diatoms appeared to be still more resistant, and required one part per million of chlorine in excess. 3. Animalculæ, like daphnia and cyclops, are not killed by even larger doses of chlorine, and were found actively mottle after a month's treatment with eleven parts per million. 4. The addition of one part of copper sulphate per million was not successful with lake water, as it did not clarify, and the green growth was only slightly retarded. The effect was not equal to the use of 1.2 parts (0.2 in excess) of chlorine per million. 5. Under the microscope a distinct bleaching of the colored algæ was noticed with upwards of two points per million of "available chlorine." this cannot occur without strong physiological action. An exception to this occurred in Experiment No. 2 (with the lake water), where the desmid, *ankistrodesmus*, was not bleached by 2.02 parts per million, and after some four weeks inhibition appeared to be starting fresh growth.

In the case of drinking water treated with 0.44 parts per million, and infected with confervæ no growth occurred, and practically the only alteration in the chemical analysis was a reduction in the oxygen consumed figure, with an increase of the chloride from 2.1 to 2.4 parts per 100,000.

Hypochlorites and Sewage Treatment.

The report for 1905 of the directors of Oxychlorides, Ltd.,

to their shareholders, states that during the year the process and plant at Guildford have been under observation by the Royal Commission on Sewage Disposal, and it was in anticipation that the Commission's report would be available earlier that the shareholders' meeting had been delayed. Syndicates have been formed in Australia and in New Zealand for acquiring the company's rights. Those syndicates are purchasing from the company machines and dynamos, and also paying the incidental expenses.

The Iron and Steel Institute Meetings.

At the outset I must confess that the heading of this section does not adequately represent its contents. Really a longer title indicating the fact that the meetings were jointly held would perhaps have been better. This being cumbersome, and as the hosts, the Iron and Steel Institute, were at home, and as the guests were the American Institute of Mining Engineers, a shorter title will perhaps serve.

The meetings proper began on Tuesday, July 24, Mr. R. A. Hadfield presiding. As an opening, Mr. Hadfield tendered a hearty and cordial welcome to the guests, and dwelt on the importance of such meetings between the metallurgists of mother and daughter country. Such visits served to strengthen the already strong bonds between the two countries, and he recalled a soldierly pronouncement of Gen. Sherman's on the occasion of the visit of the Iron and Steel Institute in 1890 to New York. From international questions of political moment, Mr. Hadfield turned to statistical and financial questions, alluding to the great increases of production in the States, to statistics of trade, to increased pig iron productions, and to the risks of ore exhaustion.

Sir James Kitson then echoed Mr. Hadfield's words of welcome, remarking that the recent and regretted deaths of Sir Lowthian Bell, Sir Bernard Samuelson and Sir David Dale had left him with the melancholy distinction of being the senior past-president. He recalled some reminiscences of his visit with the Iron and Steel Institute to New York in 1890, when Abraham Hewitt had alluded to him as a manufacturer of fossil—*i. e.*, Yorkshire—iron. To this he demurred, for fossils of this nature were still "going strong." Although in the United Kingdom they could not rival the colossal figures of production in the States, he must point out that this fossil country now used more coal and produced more iron and steel than ever before in its history. In cordial words he bade the guests welcome, and hoped that their visit would be both happy and useful.

Capt. Robert Hunt then appreciatively acknowledged the welcome, and spoke of American indebtedness to British ideas, which they had tried to expand and to carry perhaps to a greater point of perfection, and certainly to greater dimensions in production.

After various items of formal business, three papers dealing with large gas engines using blast-furnace producer, and coke-oven gas, were read in abstract. Two by Mr. Bennett Brough (the paper on Belgian gas engines, by Prof. Hubert, and the paper on German gas engines, by Herr Reinhardt), while the third paper, on English installations, was read in person by Mr. Tom Westgarth. As a postscript to the paper Mr. Westgarth remarked that he regretted being unable to present any information regarding the large 500 and 1,000-hp. vertical marine type engines with which Messrs. Beardmore & Co. were experimenting. If the reversal of this could be secured, the type would be of considerable value for rolling mill work.

Mr. Julian Kennedy remarked that in the States they were only beginners in the gas engine business, and recognized the need of cleaning the gases. Dr. Raymond lightly alluded to the omnious signs of a deluge of gas engine papers which would shortly descend upon him. He would welcome it as bringing knowledge, for, as a general rule, the only two people who really appreciated a paper were the author and the proof-reader. The gas engine promised economies, and the third place of decimals was worthy of attention in regard to savings. Prof. Kent said that hitherto Americans had hung back to see how things were going. They remembered that in regard to electric transportation the pioneers had lost money—those who waited stepped in at the end of five years and made profits, when the pioneers were scrapping their plants. They had now concluded that others had done enough scrapping, and were now securing licenses to manufacture the successful types. Another point was that blast furnace gases were irregular in quantity and quality; he, therefore, recommended auxiliary producers with bituminous coal, or coke-oven gases.

Mr. Duff then praised Herr Reinhardt's paper, and gave a retrospective account of his experiences seven years ago, when he had a surplus from some coke ovens thrown on his hands. There were no 500-hp. engines then available, so that he had to fall back on two 250-hp. engines. None of the three papers had mentioned an installation at Madrid, of Duff producers of Nurmberg engines, one of which had run for six months practically without a stop, no tar troubles arising.

Mr. Hamilton pointed out that in England the gas engine had got quite beyond the initiatory stage, and that now rapid developments might be anticipated. The competition of the future would settle the question of the relative values of two and four-cycle engines. Personally he attributed the latter to the poorness of furnace gas. He regarded the former as more efficient as an engine, but it must be remembered that where producer gas was employed radiation and other losses occurred at the producers.

Mr. Tannett-Walker said that he had been interested in gas engines all his life, and praised Herr Reinhardt's paper as a masterly treatise on the subject. Eight years ago he had been assured of gas engine perfection. Then it was certainly imperfect, and he had yet to be convinced as to the fulness of its present perfection.

After brief remarks by Mr. Mark Robinson and Prof. Turner, the one as a builder of gas engines for dynamo driving, the other as a user of several small gas engines, the largest of which was of 150 hp., Mr. B. H. Thwaite commenced to read the high sarcastic views of an aggrieved and neglected pioneer. He protested aginst the use of the word simultaneous as entirely inapplicable. As to gas cleaning, why the methods described by Herr Reinhardt as the latest evolution were substantially those disclosed in the Thwaite patent of 1894. A tactful whispered closure by Mr. Hadfield induced the speaker to omit several pages of protest, holding this over for the communications. A vote of thanks then brought the first day's meeting to a conclusion.

(Abstracts of various papers presented before the joint meeting of the Iron and Steel Institute and the American Institute of Mining Engineers will be found on pages 349 to 356 of our present issue, with some notes on the visit of the members of the American Institute of Mining Engineers to Germany.)

Market Report for July.

The most prominent feature in the metal markets during the past month has been the fall in the price of tin. Starting at £179 (3d) the price fell in the course of the week to £165. Since then the price has recovered, somewhat nervously, to £171, closing on Wednesday, the 27th, at £170.10 for cash, and £170 for three months. The fall is probably largely due to selling on the part of speculators who came in late during the boom.

The market is now a good deal steadier. Copper has experienced no very great differences, ranging from £81 to £78. As there is no surplus of material, the dealers can command prices. The closing on Wednesday were £82.2.6 and £81 for three months.

Pig iron has remained steady. Closed 51s. 4d. cash, 51s. 7½d. one month.

Lead, steady, closing at £16.16.3 (English pig). Quicksilver, per flask of 75 pounds, £7.5.

Manganese ore (50 per cent and over) 1/1 per unit. Spelter, steady, closing £26.12.6.

SYNOPSIS OF PERIODICAL LITERATURE.

A Summary of Articles Appearing in American and Foreign Periodicals.

INDUSTRIAL ELECTROCHEMISTRY.

The Measurement of Temperature in the Formation of Carborundum.—The results of an investigation for the purpose of determining the formation temperature of carborundum as well as the temperature at which it decomposes into graphite and silicon, are given by the experimenters, Messrs. Tucker and Lampen, in the *Journal of the Am. Chem. Soc.*, July, 1906. As fairly sharp lines of demarkation are observed between the layers of graphite, carborundum and siloxicon after a run of a carborundum furnace, the temperature might be obtained by temperature measurements at different points of the cross-section, after the furnace is brought to a stationary condition. A horizontal graphite tube was, therefore, placed through the center of the furnace, which tube contained a plug which could be pushed to any desired section, and its temperature measured by an optical pyrometer. The laboratory furnace, in which the experiments were conducted, was built on the general plan of a furnace used in the manufacture of carborundum, and filled with about 8 kilos. of a charge consisting of coke, 34.2 parts by weight; sand, 54.2 parts by weight, and sawdust, 9.9 parts by weight. A tube, bored out of Acheson graphite, 330 mm. long, 25 mm. outside and 18 mm. inside diameter, was put transversely through the center of the furnace. A graphite plug, 17.5 mm. in diameter and 9 mm. long, was put into the tube. The instrument used was a Wanner optical pyrometer. The method of carrying out the temperature measurements is briefly described, and the results are given. The authors found the decomposition point of carborundum into graphite and silicon to be at 2,218° C., and its formation temperature, that is, the point where the amorphous turns into crystalline, at about 1,920° C. From another experiment the decomposition point of carborundum was found to be 2,223° C., and the formation point 1,980° C. The line between siloxicon and carborundum is always less defined than that between carborundum and graphite. The average of the formation point is given as 1,950° C., and of the decomposition point 2,220° C.

Electric Steel Furnace.—During the recent trip of the American Institute of Mining Engineers through Germany, a visit was paid to the works of Richard Lindenberg in Remscheid, where the Héroult electric steel process is used, as developed by the engineers of the works and of the Elektrostahl Gesellschaft. The process is in all essentials the same as at the Holcomb Steel Works in Syracuse (our May issue, p. 164). The following description of the Lindenberg works is taken from *Iron Age*, Aug. 30: "Dr. Héroult himself was a member of the party, but, as was explained, had not visited the works before. The methods were explained by Dr. Fr. Eichhoff, consulting metallurgist, and by Mr. Lindenberg, the manager of the works. It was frankly stated, however, that some of the details of the practice developed at the Remscheid works were withheld. The plant consists of a 2-ton Wellman open hearth furnace, in which the raw material, principally scrap, is melted down, and the process is so conducted that the steel is over-oxidized. The steel is then transferred to the Héroult electric furnace, where the operation is really that which is known in crucible steel practice as 'killing' the steel. The quantity charged is about 2 tons, and the steel is purified in the electric furnace by the addition of scale or ore, and thus the elements in the metal, like silicon, carbon, manganese and phosphorus, are oxidized, sulphur, however, being an exception. The slag is cast off by tilting the furnace. Then a neutral slag is formed in the furnace by additions of lime and sand, under which deoxidation is carried on by means of carbon. Manganese, tungsten or other additions to the steel may be made to it by adding to the covering slag oxides of manganese or tungstic acid, and it is a special advantage of the method that practically all of the manganese thus added is recovered in the steel. The fact that the slag is white shows that no iron or other oxides are left in it. The yield therefore is high, being on an average 92½ per cent in the form of hammered blooms. The phosphorus contents of the steel have averaged 0.005 and of sulphur 0.012 per cent. The charge requires from 2 to 2½ hours independent of the size of the furnace. At Remscheid experience has shown that with a 2-ton furnace the cost of steel can be brought down to 120 marks ($30), and it is estimated that with a 10-ton furnace it can be brought down to 90 marks ($22.50) per ton. With a 2-ton furnace the requirement of electric power is 360 kw. per ton of steel, and it is estimated that with a 10-ton furnace this will be reduced to 150 kw. At Govtfors, Sweden, a 5-ton electric furnace has been in successful operation for a considerable period. During the visit of the engineers a cast of steel was made which poured quietly, while the stock of hammered blooms at the works and samples of bars which were shown proved it to be of a high quality."

Bleaching and Sterilizing by Means of Electric Discharges.—In our July issue, page 278, we referred to the method of Leetham for bleaching flour by means of a mixture of ozone and nitrogen oxides produced from air by means of electric discharges. Some notes on experiments in this line were given by S. Leetham and W. Cramp, at the York meeting of the British Association for the Advancement of Science, abstracted in London *Electrician*, Aug. 10. The effect of increasing the number of spark points in series to raise the necessary voltage, but not proportionally to the number of sparks, and a similar rule holds for an increase of length of spark gap. High-air speed also raises the pressure and sets up violent oscillations in the circuit. When the air resistance is high, ozone is the chief product. The ionization is then less marked. Ozone and oxides of nitrogen, contrary to many authorities, may commonly exist together without mutual destruction.

METALLURGY.

GOLD.

Cyanide Practice at the Liberty Bell Mine, Telluride, Col.—In the *Engineering and Mining Journal*, July 28, Mr. W. E. Tracy outlines the method for treatment of a decomposed quartz ore containing a large amount of clay and shale, and the sticky nature of which prevents fine crushing before being fed to the batteries. There are eighty 850-pound stamps in the mill, to which solution containing 1 pound of cyanide per ton is fed in the proportion of four parts solution to one part of ore. The stamp duty is 4.3 tons per 24 hours, 14-mesh No. 22 iron wire screens being used. There are also provided three Abbé tire-type tube mills, equipped with spiral feed. Cast iron tires and rollers have proved too soft, and have been replaced by rolled steel, which is proving satisfactory. The spiral feed is also stated to prove satisfactory. The linings, which were at first 2.5 inches thick, laid flat, have been replaced with such 4 inches thick, promising one year of life. Imported flints are used, and they are fed to the mills daily at a rate of about 1.3 pounds per ton of ore. Each mill is driven by a 50-hp. induction motor. The sand, fed to the mills by two Dorr scraping sizers, contains about 11 per cent of slimes and 45 per cent moisture; 88 to 90 per cent of the discharged product will pass a 100-mesh screen. The tube mills take approximately 55 per cent of the mill product, or 95 tons each for 24 hours. The slimes and the tube mill discharge are passed over a second

set of amalgamated plates, six tables taking the product from one tube mill. The pulp from the tables passes through spitlutten to the settlers; the over-size is returned to the tube mills. Lime is added to the pulp in sufficient quantity to insure the solution being slightly alkaline when it reaches the second plates. The five settlers are each 33 feet in diameter by 10 feet 8 inches effective depth, slightly coned at the bottom. After settling about 14 hours, approximately one-half of the solution is decanted. The remaining pulp, consisting of two parts of solution to one part of ore, is discharged to the six agitators through central bottom discharge valves. The agitator vats are 17 feet in diameter by 11 feet to the top of the 45° cone. They hold 35 tons of dry ore per charge. A sufficient amount of cyanide in solution is added, to raise the strength of the solution to 1.5 pounds per ton. The pulp is agitated for 12 hours, and then discharged to an equalizer tank, from which it is drawn as required to the Moore filter plant. The latter contains two loading and four displacing tanks. There are four baskets, each containing sixteen plates, 6 x 8 feet, giving 6,336 square feet of filtering surface per basket. The filtering frames are covered with 20-ounce duck. The baskets are raised and lowered by two 30-ton hydraulic cranes, driven electrically. The pulp in the loading tanks is prevented from settling by air-lift agitation. Each basket remains in the loading tank for 1 hour, during which time about 16 tons of solution are drawn through the filters, and a ⅞-inch cake is formed with a vacuum of 17 to 19 inches. The basket is then transferred to the displacing tank, where the gold-bearing solution is displaced by water, an intermediate weak solution being used. The cakes leaving the loading tank contain about 33 per cent of moisture, about 75 per cent of which is drawn in from 30 to 40 minutes after the basket is transferred to the displacing tank, with only a trace of dilution. When the solution from the vacuum pump begins to show dilution, it is directed by a swinging nipple into a weak solution launder, from which it passes through the weak solution zinc boxes to waste. The values fall off rapidly after this point, the average time of displacing being about 1 hour and 20 minutes. Displacing is discontinued when the discharge from the vacuum pump shows 0.35 pound KCy per ton. This procedure leaves from 5 to 7 cents per ton of dry slime in the cake and about 3 cents worth of cyanide. Water at 10 pounds pressure is then turned into the baskets, and the cake blown under water in the displacing tank. The strong solution from the Moore filters is combined with the decanted solution, and passes through a clarifying filter and then to the zinc boxes. The latter are twelve in number, five compartment, each compartment containing 20 cubic feet of zinc. Two of the boxes are used for weak solution. The strong solution averages 1.2 to 1.3 pounds KCy per ton, and the weak 0.75 to 0.8 pound per ton.

Crushing and Grinding Practice at Kalgoorlie.—The much-debated question of tube mills versus grinding pans, which, on account of the comparative tests of the two apparatus at the Ivanhoe mill, in which the pans appeared to better advantage, has been brought prominently before the metallurgical world, is taken up again by Mr. A. James in the *Mining and Scientific Press*, July 28. His remarks refer to West Australian practice. He believes that if better concentration can show a reasonably free cyaniding product, the necessity at Kalgoorlie for tube mills disappears. It is, however, by no means yet decided, and rather the reverse, that concentration as practiced in the district, is yielding a product capable of being bromo-cyanided without the very finest sliming, such as it appears only tube mills can as yet accomplish. An attempt to obtain Dr. Diehl's bromo-cyanide extraction by bromo-cyanide alone, without Dr. Diehl's bromo-cyanide method, namely, tube mill fine sliming, is apt to yield as poor results as are shown by one of the best mines in Kalgoorlie, where the residues, even with an ore supposed to be comparatively free from refractory minerals, are stated to be the highest in the neighborhood, 2½ dwt. per ton. The author then discusses more particularly the tests of tube mills versus grinding pans at the Ivanhoe plant, above referred to, and claims that, in comparing the relative efficiencies of pans and tube mills, an extraction test would have been more useful, more accurate and more practical than the Ivanhoe tests. He believes that the tube mill was choked with slime and could not do its most effective work, and that, therefore, the results show only a fraction of the work done elsewhere per horse-power-unit. He claims that the tests were unworthy of serious notice, mainly because the lack of opportunity for the free escape or removal of the finished tube mill product reduced them to an absurdity. On the other hand, the pans, especially the first pan, were allowed a much better opportunity of getting rid of their finished product, though even here the arrangements might have been improved. The author also refers to the difference of opinion locally regarding the working of the pans. At the Ivanhoe mill, the pans are provided with compensating weights, and they are highly thought of. At the next mine which the author visited, however, he was told that the compensating weight rings had been thrown out as having proved to be of no advantage whatever. At the next mine he was told that the old original 8-foot pans first introduced were the best pans on the field, and these 8-foot pans are being adopted for the most recent plants. He concludes with a plea for more authoritative work in this important matter.

Tube Mill Lining.—The practice of ore treatment at the Waihi mill, New Zealand, consisted of crushing under stamps to 40-mesh, the finer the pulp discharged from the battery the better the extraction in the cyanide plant. There was a limit to fine crushing, however, as beyond 40-mesh the stamp duty was decreased until fine pulverization became uneconomical. The Waihi was, therefore, one of the first plants to introduce the tube mill, which latter has proved most effective for regrinding. At the present time the stamps crush only to 15 or 20-mesh, the battery product being reground in tube mills to 150-mesh. The tube mills are provided with a special lining, designed and patented by Mr. H. P. Barry, the superintendent of the works. This lining is described and illustrated in the *Mining and Scientific Press*, July 28. Formerly it was very expensive to line the tube, silex from Iceland being used, which was laid with a special cement. It cost £80 to line a mill, and the time of service was only three months. Mr. Barry utilizes the flinty portions of the Waihi ore, and lays them in Portland cement; the lining costs £40 and lasts six months. The lining is formed of cast iron segments, which are curved to the shape of the tube, in sections having four or six divisions, each 4 x 6 inches. The following are the costs which have been found in actual operation:

Honeycombed casting, 28 cwt., at 15s.	£21
Broken quartz, 5 tons, at 20s.	5
Portland cement, 1 ton at mine, at 11s. per cask...	4½
Sand (rough tailing), 1 ton	1
Labor at 9s. per day	8
Total	£39½

It is claimed that, as the casting can be made for 12s. per cwt., and the cost put down for quartz is rather excessive, the liner can be made for £30. The saving is stated to be about £260 per tube per annum. As the company is about to use ten or twelve tube mills this saving represents an important item.

Mining and Milling by Electric Power Machinery.—In the course of an illustrated article in the *Engineering Magazine*, August, 1906, on the application of electric power for driving various mining machines, Mr. C. V. Allen makes some remarks concerning the electric driving of stamp mills. According to him, in the electrical equipment of such mills the more usual practice is to drive the main shaft in sections, which in turn drive the cam shafts, so as to give the stamps from 100 to 104 drops per minute, there being two drops of the stamp to

each revolution of the cam shaft. He states that there are probably more mills equipped with 50-hp. motors driving units of twenty stamps each, though a few are operating with 100-hp. motors on forty stamps, and some with 350-hp. synchronous motors, driving an entire mill of 100 or 120 stamps. In almost all such installations as this last one referred to the mills were formerly driven by steam, and the steam connections are left as much intact as possible, if for any reason it should prove desirable or necessary to use steam. This method, of course entails considerable loss by friction in long-line shafts, and means also a complete shut-down of the mill in case of accident to the motor or transmission. The author thinks that there is little doubt that such drives in time will be changed to unit drives, as confidence is established in continuous electrical service. The ore crushing plant is a simple application of an induction motor of proper speed and horse-power, depending on the size and type of crusher used. One or more can be belted to the motor or to jack shafts driven by the motor. With this type of motor two pulleys can be placed on the motor shaft, extended on both sides, if desired, to drive two crushers. The fly-wheel of the crusher, together with the fly-wheel capacity of the motor rotor, is ample, with a motor of proper capacity, to withstand the heaviest shocks due to large or hard ore. In a cyanide plant, according to the author, the ideal condition is the application of individual motors to each machine, or small group of machines, as in the case of the mechanical agitators. By this method any one machine may be stopped when no work is to be done, or when repairs are necessary.

The Valuation of Shipping Ores.—In an article in the *Mining and Scientific Press*, July 14, Mr. R. Gilman Brown discusses the question of valuing ores for smelting purposes. He takes the case of a complex ore, which is free-milling to a certain extent, carries lead in appreciable amount and iron and zinc in sufficient quantity to modify the charge on the concentrated product. The tailings can be treated by cyanide, and yield a small but noteworthy product. For an average product the return from the books for a month show as follows:

Tonnage.	*Total.*	*Per Ton.*	*Per Cent.*
Saved by amalgamation...	$3,132.42	1.98	37.1
Saved by cyanide.........	1,123.59	0.71	13.3
Realized from concentrates	2,563.41	1.62	30.4
Lost in tailings...........	......	1.02	19.2
Total	......	5.33	100.00

Thus, it appears that the ore assayed $5.33 per ton, and that over 80 per cent is being recovered. However, the case appears different, when a single lot out of the six, which make up the shipment for one month, is taken. The basis of settlement is 95 per cent of the silver, 95 per cent of the gold at $20.00 per ounce, 90 per cent of the lead at 1 cent per pound, London quotation, with a reduction of 10 cents per ton for each unit above 10 per cent; 10 per cent zinc is allowed, 50 cents per unit being charged for each unit above this. The excess units of iron over silica are credited at 10 cents per unit per ton. Freight and treatment charges amount to $9.00 per ton. The smelter analysis was: 11.5 ounces silver, 0.95 ounce gold, 12.1 per cent lead, 10.3 per cent zinc, 28 per cent iron, 4 per cent silica, weight 19.386 tons. The following table gives the values of the shipment:

Metal.	Quantity.	Gross Value.	Deduction.	Net Value.	Gross Value Rec'd.
					%
Silver....................	222.94 oz.	$136.83	$6.84	$129.99	95
Gold......................	18.417 oz.	380.68	12.34 18.42	349.92	92
Lead......................	4.691 lb.	139.38	46.91 9.25 4.07	79.15	57
Iron and Silica...	....	46.53	....	46.53	100
Total..................	....	$703.42	$97.83	$605.59	86

DEDUCTIONS.

Excess zinc..............................	....	$2.91	....	.....
Freight and treatment	....	174.47	....	.....
Total..	$703.42	$275.21	$428.21	61

There were 115.3 tons of concentrates produced from the 1,580 tons of ore, making the proportion 7.3 per cent. The lot analyzed weighed 19.386 tons, thus the average represented 265.6 tons. Consequently, the gross value of the gold and silver in the concentrate is $1.94 per ton of ore, of the lead $0.52, of the iron and silica $0.17; a total of $2.63 being required to produce $1.62 from the sale of the product, the difference covering the various charges imposed by the smelter. It is thus seen that it is more or less difficult to figure out whether a block of ore is payable or not, but when the grade of ore and the degree of concentration are fairly uniform, an empirical factor can be deduced. This factor is 83 per cent in the present case, that is to say, the value realized by sale is 83 per cent of the precious metal value in the concentrate. Taking an average of 82 per cent for the shipments of the month under consideration, the corrected value per ton of ore is as follows:

Saved by amalgamation......	$1.98	35.2%
Saved by cyanide............	0.71	12.7
Saved in concentrates........	1.98	35.2
Lost in tailings..............	0.95	16.9
	$5.62	100.0

Thus, from an ore assaying $5.62 in gold and silver values there will be realized $1.98 + 0.71 + 1.62 (1.98 × 82 per cent) = $4.31 or 77 per cent, which will be in the proper figure to use for calculating the value of any particular block of ore. The simplest case in valuing ore occurs when the whole product is shipping ore, where estimates should be based on analyses of group samples, representing average constituents of blocks or parts of blocks.

COPPER.

A New Matte Separator.—In a paper read before the recent meeting of the Canadian Mining Institute, Mr. R. R. Hedley describes an arrangement which has been successfully used for some time at the lead smelting works of the Hall Mining & Smelting Co., at Nelson, B. C. It is the invention of Mr. H. Harris, and is based upon the idea of maintaining, outside of the furnace, the fairly complete separation of matte from slag which has taken place inside the furnace, instead of, as is usual, to allow the matte and slag to flow together to a receptacle, where they have to be separated again by gravity at a lower temperature. As shown in plan and vertical cross-section in the adjoining illustration, it consists essentially of an L-shaped cast-iron box, about 30 inches long, placed in free communication with the tapping hole, which latter should be as wide as possible. The apparatus is pressed close to the top jacket E of the smelting furnace, with its bottom on a level with the bottom of the tap hole F. When the furnace is in full operation, the matte and slag will be maintained at levels corresponding to the head afforded by the height of the slag

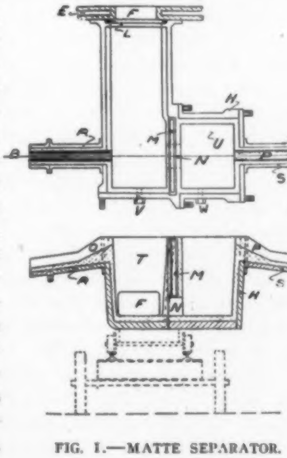

FIG. 1.—MATTE SEPARATOR.

and matte overflow O and P. The slag from the double stream flowing from the furnace will be arrested by the water-jacket barrier M, and will be maintained in the first compartment T to overflow at O. The matte will flow through the opening N into the second compartment U, and will rise until its head balances those of the matte and slag in the first compartment or the matte slag and blast pressure in the furnace, and will overflow at P. Thus the levels of matte and slag in the furnace will depend upon the weight of the blast and the height of the overflows O and P, which may be varied considerably at the will of the furnace man. The tap hole V serves for tapping out any small quantity of lead which may accumulate, and may also be used for tapping out the contents of the furnace when necessary. The author states that the device has now been perfected and is a regular adjunct of the furnace. The following advantages are claimed for it in comparison with the settling in forehearths: A better saving of lead and silver values in the slags; a more perfect equilibrium in the furnace, which is conducive to more perfect metallurgical work and less tendency to irregularities, which produce troublesome crusts and accretions; less time is lost in changing settlers; a saving of labor is obtained in handling the settlers and preparing the contents for resmelting; and, lastly, there is a saving in iron and steel tools as well as in matte pots. The apparatus is mounted on small wheels, which run on rails on a truck placed at a height corresponding to two short rails at the furnace. It will run for two or three weeks without change, which is quickly effected. It is not bolted to the furnace, the connection being made by tamping a small quantity of fireclay in the groove L, which, when filled with slag which chills between the surface of the packet and the flange, makes an efficient seal.

Electrolytic Treatment of Copper Ore at Miedzianka, Russian-Poland.—The ore at this locality consists essentially of copper glance, which is at times oxidized to azurite and malachite. It is treated by an electrolytic process, which is described by W. Stoeger in the *Oest. Zeitsch. für Berg. und Hüttenwesen*, July 28. The ores are crushed and then roasted to a certain extent, the object being to obtain a mixture of copper sulphate and copper oxide. The roasted ore is lixiviated with dilute sulphuric acid, the copper being obtained as copper sulphate. The solution is then electrolyzed until only traces of copper remain in the electrolyte, a corresponding quantity of sulphuric acid being formed during electrolysis. This electrolyte is then again available for dissolving fresh quantities of ore. As the roasted ore contains the greater part of its copper in the form of sulphate, the amount of free sulphuric acid would increase after repeated extraction and electrolysis. However, there always remains some liquid in the ore residue, which has to be replaced by water. It is claimed, moreover, that as the electrolysis is not affected by varying amounts of free sulphuric acid, as well as by other salts, it is not necessary to keep the percentage of free sulphuric acid at a certain well-defined figure. The pulverized ores are mixed with 5 per cent of moist loam and formed into briquettes, which are first dried by the waste gases of the roasting furnace and then introduced into the latter. As the briquettes are porous, the roasting gases penetrate into their interior, and it is therefore possible to roast 10 tons per day in a small furnace. The roasted briquettes are again pulverized and brought into shallow vats, where they are treated with the dilute sulphuric acid obtained by the electrolysis. The solution thus obtained is clarified by filter presses. The copper is precipitated in vats similar to those used in the electric copper refining process, but with anodes of sheet lead, which are wrapped around with a textile fabric (Barchent). Circulation of the electrolyte is effected by stirrers, actuated by an eccentric. The vats are filled with the solution extracted from the ore. The solution contains about 5 per cent of copper and 1 per cent of free sulphuric acid. A current of 1,000 amperes, corresponding to a current density of 1 ampere per square decimeter of cathode surface, at 2.5 volts per vat, is passed through. The quantity of copper deposited amounts to 1.1 grams per ampere-hour, which is close to the theoretical value. The amount of electric power per 1 kilogram of copper is therefore 2.28 kw-hours, or 3.5-hp. hours. As one vat contains about 1 cubic meter of solution, the latter is in 35 hours sufficiently low in copper, that is, from 1½ to 1 per cent, to be run off and used again for extraction. The free sulphuric acid has by that time reached about 5 per cent. The ores are very rich, and the copper lost in the solution remaining in the residue is very small, even if the extracting solutions contain 1 to 1½ per cent of copper. This would, however, not be the case with poor ores; in that case electrolysis is continued until the solution contains only 1/10 per cent of copper, a lesser current density being used towards the end of the operation. Electrolysis is continued for about 1 month, until the copper cathodes are about 20 to 30 millimeters thick. It is stated that the cathode copper has an even red color and is nearly chemically pure, purer yet than the electrolytic copper from the refineries. The current is furnished by a dynamo of 12 volts and 1,000 amperes, power being obtained from a waterfall by means of a 50-hp. Francis turbine.

The Constitution of Copper Matte.—A good deal has been written regarding the constitution of copper matte, owing to the importance of the matter for the copper smelting industry. In the latest contribution to the subject, in *Metallurgie*, July 22, 1906, P. Röntgen bases his conclusions on laboratory experiments, carried out by melting together copper sulphide and

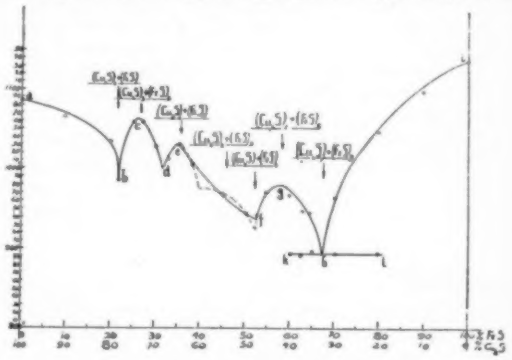

FIG. 2.—COOLING CURVE OF COPPER MATTE.

iron sulphide in different proportions in an electric furnace, for the purpose of constructing the cooling curve, the temperatures being measured with a Le Chatelier pyrometer. The investigation was supplemented by the microscopic examination of the products obtained. In making the melts it was observed that metallic copper crystallized out, which fact introduced a disturbing factor. The author gives the following explanation concerning this segregation of copper. In the liquid matter there is present Cu_2S besides FeS. During solidification a part of the FeS seizes upon the sulphur of a part of the Cu_2S and is itself converted into FeS_2. This change does not take place quantitatively, because the time of solidification is too short or the reaction approaches a state of equilibrium. The FeS_2 thus formed forms with a part of the copper sulphide a substance of different fusibility from that of a melt of Cu_2S and FeS, so that a part of the regulus separates out. He intends to investigate this problem further. The results of the investigation are given in the accompanying illustration, which represents the cooling curve. At *a* is the solidification point of the pure Cu_2S. The author deduces the following compounds from the appearance of the cooling curve: At *a*, Cu_2S; at *b*, a eutectic of the approximate composition $(Cu_2S)_3$ + FeS, $a + c$; at *c*, sulphosalt $(Cu_2S)_3$ $(FeS)_2$; at *d*, eutectic $(c + e)$; at *e*, sulphosalt Cu_2S, FeS; at *f*, eutectic $(e + g)$; at *g*, sulphosalt $(Cu_2S)_2$, $(FeS)_3$; at *h*,

eutectic (g + FeS); at i, FeS. Consequently, at least three chemical compounds would exist between Cu_2S and FeS. The branch $e - f$ of the curve is peculiar inasmuch as it is not convex upwards as the other parts of the curve. The author thinks that this is perhaps an indication that the curve runs different in reality; perhaps another maximum exists there, so that the curve would follow the dotted line. This part should be further investigated.

The Tacoma Copper Refinery.—This plant is located about 6 miles from Tacoma, Wash., on the shore of Puget Sound. It is driven throughout by electricity, the current of 40.000 volts tension being transmitted from the generating station at Electron, Wash., in the foot hills of Mt. Rainier. The current is reduced at the works to 100 volts, and about 2,000 hp. are utilized in the various departments. A brief illustrated description of the smelting works is given by Mr. D. A. Wiley in the *Engineering and Mining Journal*, July 28. A feature is a circular slag casting machine, which is intended to do away with much of the ordinary labor required to break up and remove the slag. The machine has a total capacity of 20 tons, 144 tilting molds being used. It is located at the side of the building where the furnaces are installed, and is served by an electric crane, which removes the ladles as fast as they are filled at the slag spout, and empties them into the molds. A reverberatory furnace is employed for the reduction of concentrates. The matte averages from 45 to 55 per cent copper. The molten matte is tapped into ladles, by which it is carried directly to the two converters, and blown by 3,500 cubic feet of air to each converter per minute. The furnace for casting the anodes is of the rotary type, and is heated by oil. It is also served by an electric traveling crane from the converter. The metal is cast into anodes weighing 125 pounds on an average. In the electrolytic department the cathodes are removed from the vats by an electric traveling crane and returned to the furnace department, where they are melted and cast into ingots, cakes, etc. The average daily output of the works is 30 to 43 tons. The ore smelting reverberatory has a capacity of 350 tons.

LEAD.

Remarks on the Formation of Flue Dust and Furnace Accretion in Lead Smelting.—In *Metallurgie*, July 8, 1906, F. O. Doeltz and C. A. Graumann give a brief résumé of experiments made to determine the volatilization temperature of galena and lead sulphate. They summarize their conclusion as follows: 1. Galena is much more volatile than lead oxide and is volatile to a high degree already at a temperature of 860° C. At this temperature 18 per cent of loss were found in an hour. This fact furnishes an explanation of the large accretions of galena in the lead smelting furnaces; 2. The small veins of galena which are found in the walls of reverbatory or hearth furnaces when the latter are torn down may be formed by sublimation, that is, by the condensation of galena vapors; 3. Lead sulphate is not very volatile, but undergoes strong decomposition already at 1.000° C., contrary to statements made by other authors; 4. The lead sulphate found in the flue dust has in the main been formed subsequently from Pbo and SO_3, or possibly PbS and O.

ZINC.

Remarks on the Distillation of Roasted Blende and the Calcination of Galmei.—Induced by the observation made at the Friedrichshütte smelting works in Upper Silesia, that roasted blende which had been exposed to the action of the atmosphere for a considerable time gave a better yield of zinc than other blende, F. O. Doeltz and C. A. Graumann conducted some experiments, the results of which they briefly describe in *Metallurgie*, July 8, 1906. They found that finely divided, cold, zinc oxide, kept evenly moist, can easily be converted into zinc carbonate by carbonic acid. The decomposition of zinc carbonate by heating is easily shown by baryta water, even at 137° C. A long continued, strong ignition is necessary for complete decomposition. The authors tentatively express the opinion that if roasted zinc blende, on account of remaining for a considerable period in an atmosphere rich in carbonic acid, takes up carbonic acid and is thereby partly changed into zinc carbonate, this amount of zinc carbonate exerts perhaps in the subsequent distillation process a similar favorable loosening influence, as the carbonic acid in the roasting and distillation of galmei. Graumann observed that when ZnO made from $ZnCO_3$ was pulverized, it did not become granular even after repeated ignition, but remained always loose and soft, and did not offer any resistance to pulverization. Quite contrary to this is the behavior of commercial zinc oxide as well as of the zinc oxide made from zinc sulphide.

Ore Milling in Wisconsin.—An article in the *Engineering and Mining Journal*, July 28, reviews briefly the practice and recent progress in the Wisconsin zinc-lead district. With regard to magnetic separation, the author states that the Wetherill separator has never been used in the field, owing to the royalty and the higher first cost. The two separators in regular use are the Cleveland-Knowles and the Dings, the latter of which is new and has only been used as yet at three places in the district. The separator has a low-intensity field and two magnets, a rougher and a cleaning magnet. The two types are stated to do about equally good work and to use about the same amount of power. Roasting is most important in preparing the ore for magnetic separation. Three roasters have been experimented with in the district, namely, the Dings, the Trego and the Galena. The latter alone is stated to have as yet established itself as a success. It operates on the principle of obtaining a slow, low roast, while the other two attempt a quick, high roast. It consists of a dust chamber and a fire-box, connected by a brick-lined iron cylinder, about 22 feet long and 52 inches diameter, rotating on tires by means of a gear wheel. The ore remains in the kiln from 2½ to 3 hours. It requires about 7.5 hp. to rotate the kiln. The roasted ore from the calciners is generally sprinkled with a small amount of water, so that the ore is perfectly dry by the time it reaches the separators. Before going to the separators the ore is sized by passing it through a trommel, one screen having ¼-inch and the other ⅛-inch openings. The sizes are kept separate, each going to a bin holding about 5 tons. One size and then the other is fed to the separator, this method of procedure permitting a better saving than the treatment of the fine and coarse together. The material obtained from the different separators throughout the district is stated to average about 59 to 60 per cent of zinc and carries about 3 per cent of iron, the saving being probably about 80 per cent of the zinc value. The middlings average probably between 7 and 10 per cent. at the different mills, and the tailings carry about 5 per cent. There is a decrease of lime in the finished ore, partly by dusting off in the furnaces and partly because some of the lime has enough iron in it to be separated by the magnets. The cost of magnetic separation is stated to vary from $1.00 to $2.00 per ton of the finished product, varying with the tonnage treated and the zinc contents of the raw ore. It is stated that at the Mills mine, near Hazel Green, a large concentrating plant is being erected, and a new method of magnetic separation is being tried. The concentrates will be roasted in a Trego calciner, and, when cooled, passed over an improved Wenström separator. A clean zinc product free from iron will be made, but in this procedure quite a little zinc will be drawn up with the iron. The impure iron product will then be passed by a shaking conveyor under a series of waving magnets, which will remove the iron and leave the zinc product in a fairly pure condition.

IRON.

Annealing and Hardening Furnace with Electrically-Heated Bath.—The process of annealing and hardening objects of steel requires a very careful supervision and regulation of the temperature, in order that the material may not

be detrimentally affected or perhaps spoiled altogether. In furnaces which are heated by ordinary methods, it is very difficult to obtain this precise regulation of the temperature, though it can be easily done in a furnace heated by electricity. Mr. L. M. Cohn, in the *Elektrotechnische Zeitschrift,* Aug. 2, describes an electric furnace constructed for this purpose. It consists essentially of a rectangular crucible, lined with refractory material, which receives the heating bath of molten salts. Two electrodes of soft wrought iron are introduced alongside of two opposite walls of the crucible. In order to prevent electrolysis, alternating current is used for heating the bath. A regulating transformer allows the precise regulation of the temperature. It has been a difficult matter to properly heat the high-priced qualities of steel, which have to be brought to a temperature of about 1,300° C. The electric furnace, however, can be brought to this temperature without any trouble. The electrolyte used for temperatures over 1,000° C. is pure barium chloride, the melting point of which lies at about 950° C. For lower temperatures, a mixture of two parts barium chloride and one part potassium chloride, the melting point of which is about 670° C., is employed. Pyrometric measurements, made at a furnace in practical operation, have shown that variations in temperature in the different parts of the bath cannot be detected, beyond a thin layer directly at the surface of the bath. The power consumed with a furnace, the melting space of which had a cross-section of 160 by 160 mm. and a depth of 175 mm., the primary voltage of the alternating current of 50 periods being an average of 190 volts, was 5.4 kw. for a temperature of 880° C., 8.5 kw. for 1,140° C., and 12.25 kw. for 1,300° C. The steel articles which are to be annealed or hardened are introduced into the bath and left in it until they have attained the color of the bath, which can easily be seen. It is claimed that the furnace is of advantage, not only in permitting the precise regulation of the temperature, but also by preventing the loss arising from spoiled material. Furthermore, the working of the furnace is very simple, and the heating proceeds much quicker than with the best gas furnaces, and, therefore, more work is done in the same time. In practical operation it has been possible to heat milling cutters of 120 mm. outside diameter, made of Novo steel, in 62 seconds to 1,300° C. The electrodes are gradually dissolved by electrolytic action, induced by the limited number of alternations of the current, which is usually 100 per second. The dissolved iron settles to the bottom of the furnace in the form of a slag, and can be easily removed with a spoon. The electrodes, when the bath is used at 1,300° C., have to be replaced after about 100 working hours, while they last about 1,000 working hours at 850° C. As they consist of ordinary soft wrought iron, the price is very low. The salts can be used for a long time, it being requisite to add about 1 kilogram per day, if the salts mentioned above are employed and an average temperature of 1,300° C. is required. At larger intervals of time, say about every twelve months, according to the temperature at which the bath is used, it is necessary to replace the crucible. The costs of operation are therefore low, especially when compared with other furnaces for obtaining high temperatures.

Coke Ovens.

By-Product Coke Ovens in America.—In a paper read before the Engineers' Club of Philadelphia, and published in the July issue of the *Proceedings* of the Club, Mr. E. A. Moore gave a review of the growth of the by-product coking industry in the United States, and especially the work of the United Coke & Gas Co. and Dr. Schniewind. He briefly describes several plants, and notes the contrast between the older methods of arranging a plant and the labor-saving appliances which have been introduced into the modern plants. The substructure which supports the ovens has been materially improved by supporting them upon steel beam work arranged upon three longitudinal walls of concrete construction. The regenerators do not have to perform any more the duty of acting as main support to the ovens, and the contraction and expansion constantly going on in the oven brickwork can manifest itself without exciting such disturbing influence as formerly. Another material improvement has been the mechanical leveling device, which is mounted upon the pusher and operated by the same attendant. This device is of great service in maintaining the uniformity of the charge and insuring practically the same amount of coal being supplied to each oven. In combination with this is another labor-saving arrangement, on the more recent plants, which consists of a door-hoisting device so arranged as to be operated by the pusher man. The oven is discharged into a coke-quenching machine, a device made large enough to receive the entire charge of the oven practically unbroken. When the oven is pushed, the doors of the quenching machine are closed, and the quenching process is proceeded with by an arrangement of a water supply trench in combination with a motor-driven rotary pump which discharges the water into the cast-iron, water-jacketed box, in which the coke has been placed, in such a manner that the coke is instantaneously deluged with the quantity of water sufficient for quenching. The author states that the present capacity of the ovens contracted for under licenses of the United Coke & Gas Co. is 5,200,000 tons, and those contracted for by the Semet-Solvay Co. is 2,800,000 net tons of coal, producing on the basis of 75 per cent output in total 6,000,000 tons of coke; although some of the plants, notably the Cambria Steel Co. at Johnstown, Pa., get a considerably larger yield. He gives the following estimate of plant of 100 ovens, with a charging capacity of 7½ tons = 750 tons of coal daily, for beehive as compared to by-product ovens. *Beehive ovens,* daily results: Expenses, 750 net tons of coal, cost at mines $1 = $750; labor, repairs and all capital charges per ton of coal carbonized at 50 cents = $375, a total of $1,125. Coke output: Coal yielding 65 per cent coke = 487.5 net tons coke; cost per net ton coke, $2.50. *By-product ovens,* daily results: Expenses, 750 net tons coal, cost at mines $1 = $750; labor, repairs and all capital charges per ton of coal carbonized at 80 cents = $600, a total of $1,350. By-product returns (actual results): Ammonia, NH_3, 3,900 at 8.5 cents = $331.50; tar, 7,627.5 gallons at 1.8 cents = $137.30; benzol, less production cost = $187.50; gas, 3,472,000 at fuel value of 10 cents per 1,000 cubic feet, $347.25 = $1,003.55. This subtracted from $1,350 leaves $346.45. Coke output: Coal yielding 75 per cent coke = 562.5 net tons of coke; cost per net ton of coke, $0.61 6/10. Or, substituting 25 cents per 1,000 cubic feet for gas sold for illuminating purposes, it figures out as follows: Ammonia, $331.50; tar, $137.30; gas, 3,472,000 at 25 cents per 1,000 cubic feet = 868.00, a total of $1,336.8. This subtracted from $1,350 leaves $13.20. The cost per net ton of coke is, therefore, $0.02 35/100. The item of freight is ignored in this calculation, as the coke would offset the coal in either case.

Photometry.

Radiation Photometry.—In a paper before the British Association for Advancement of Science, reprinted in the London *Electrician* of Aug. 17, Prof. J. B. Henderson discusses recent advances in our knowledge of radiation phenomena and their bearing on radiation pyrometry. The main laws of radiation are four in number, and refer to an "ideal black body" (*i. e.*, one which emits and absorbs impartially all wave lengths, in contradistinction to bodies of selective radiation). These four laws are the Stefan-Boltzmann law of the total radiation given out by a black body, two forms of Wien's displacement law, and Planck's law of the partition of energy over the different wave lengths in the spectrum of a radiating body. All accurate radiation photometry is based on these four laws; the commercial radiation photometers employed especially either the Stefan-Boltzmann law by measuring the total radiation, or Planck's law by confining the measurement to a single well-defined luminous wave length (like the red line transmitted by

red copper oxide glass). These latter methods may be termed as optical pyrometry, because only the luminous portion of the spectrum is used. Pyrometers based on the measurement of total radiation have a black receiving surface for absorbing the radiation from the radiating body, and this surface may be one of the junctions of the thermocouple. In a perfect pyrometer of this kind the receiving surface should be ideally black, and in some very accurate laboratory investigations cavities have been used as receiving surfaces. But the error introduced in a practical instrument, due to this defect, is almost insignificant. Optical pyrometers confining the measurement to a single wave length are simply spectro-photometers of simple form. several commercial photometers are briefly described by the author, all of which have already been mentioned in our columns.

If a radiation pyrometer is to give correct absolute values of the temperature, it must be remembered that its indications are based on the supposition of a black radiation body. Kirchhoff, to whom the foundation of the whole theory is due, showed long ago that the radiation inside an enclosure whose walls are at uniform temperature is the same as would be emitted by an ideal black body at the same temperature. If, then, we wish to obtain accurately the temperature of any material in a furnace by means of the radiation which it emits, we must take the radiation from a cavity whose walls are at the required temperature. If the material is in liquid or pulverous form, a tube closed at one end is inserted in the material and the radiation taken from the closed end. If the material is in ingot form, and there is no serviceable hole in it, we can use an auxiliary piece of similar material provided with a hole and placed against the ingot, so as to have practically the same temperature as the ingot. The hole, or cavity, may bottom against the ingot or in the auxiliary piece of material. To use a radiation pyrometer in the tempering of armor plate on a cooling curve, it would be necessary to lay another plate with holes in it on the one to be tempered, then heat the two together in the furnace, and after withdrawing them from the furnace to focus the thermometer on the bottom of one of the holes. When the required temperature is indicated the upper plate could be removed and the lower one quenched, the upper one being returned to the furnace with the next plate. In every case where the temperature is read while in the furnace, it is necessary to shield the radiation from luminous flames, after leaving the cavity. This may be done by means of tubes, and the temperature of the walls of these tubes will not affect the result, provided an image of the cavity is formed on the sensitive surface of the pyrometer.

ANALYSIS OF CURRENT ELECTROCHEMICAL PATENTS.

ELECTRIC FURNACES.

Calcium Carbide.—H. L. Hartenstein, 12,519, Aug. 17. Application filed May 10, 1906.

Several patents of Mr. Hartenstein for the manufacture of calcium carbide have already been dealt with in our June issue, page 237. In the usual processes of making carbide lime and coke are the starting materials. In the present patent it is proposed to start with limestone rather than lime. According to the inventor, ordinary lime, as generally produced in kilns, is not of the uniform and high quality desirable for carbide manufacture. Further, in lime manufacture when the burning operation is completed the lime is permitted to cool down without in any way utilizing the heat stored in it. Finally, the crushing and pulverizing of the lime has certain disadvantages. It is, therefore, proposed to start with limestone, crush it to about 20-mesh, heat it to the point of incandescence in a revolving furnace, whereby the carbonic acid gas and other gases are given off, and then while hot, add coke, ground to about 50-mesh or finer. One part by weight of coke is used for three parts of limestone. The mass is then delivered to a reservoir, from which it is charged into one or more electric furnaces to be converted into carbide. In this manner the heat units stored in the lime during the burning of the limestone are utilized, and the amount of electrical energy for the production of carbide is reduced. During the burning of the limestone a small portion of carbide dust or fines, which is not suitable for other use, is added, in order to thoroughly expel and drive off any remaining carbon monoxide and carbon dioxide. The carbide fines form a superheating compound, and thereby serve to increase the temperature of the mass and to enable the mass to retain its heat when delivered into the distributing reservoir. The inventor also adds the following superheating compound to the heated mass during or immediately before the delivery of the mass into the distributing reservoir. It consists of 60 per cent calcium carbide, 20 per cent black oxide of manganese, 15 per cent bituminous coal, 2 per cent chlorate of potash, and 3 per cent of aluminium. The aluminium serves to drive off any phosphorus that may be present in the mass. From 15 to 20 pounds of superheating flux are used per ton of material.

Silica Glass.—J. F. Bottomley, R. S. Hutton, A. Paget, 812,399, Feb. 13. Application filed March 21, 1903.

The object is the fusion of quartz and production of silica glass, the fusing point of which is above the temperature obtainable in gas or fuel furnaces as used in glass manufacture. The conditions of working are limited by the fact that by heating quartz or pure glass-makers' sand, unmixed with other substances, it is only possible to get it into a plastic state, and that further heating produces volatilization before a really fluid condition is obtained. In order, therefore, to produce articles of any desired shape, the inventors heat silica until it gets into a plastic condition by electric resistance heating, and then provide means whereby the plastic mass may be directly shaped or molded in situ into the desired form. One method of precedure is as follows: A hollow and perforated carbon rod, which serves as resistor, is embedded in a granulated mass of quartz. The Joulean heat of the current passing through the carbon rod brings the quartz next to it into plastic form, and then compressed air or gas is supplied through the hollow and perforated carbon tube, and the plastic quartz is thereby freely expanded and caused to assume any desired shape by blowing into an external mold. For details the reader must be referred to the patent specification.

ELECTROLYTIC PROCESSES.

Lead Refining.—A. G. Betts, 827,702, Aug. 7. Application filed Oct. 31, 1902.

Details of construction and arrangement of electrolytic vats for lead refining. Claim 1 reads as follows: "In an electrolytic apparatus, the combination with an electrolytic vat; a bus-bar provided with relatively wide trough-shaped cavity and a plurality of wells of relatively small cross-sectional area opening in the bottom of said cavity, and fluid metal [mercury] in said wells; of a plurality of electrodes supported within said vat, and connections between said bus-bar and the respective electrodes having terminals immersed in the fluid metal in the respective wells."

Removing Oxide Scale from Iron.—C. J. Reed, 827,179 and 827,180, July 31. Application filed June 26, 1905, and Jan. 2, 1906.

To remove oxide scale from iron sheets, rods and wire; the latter are made cathode in a strong aqueous solution of an acid, preferably sulphuric acid of specific gravity 1.20, having an acid content of 27 per cent, with a cathodic current density of 40 to 70 amps. per square foot, at a temperature of 60° C. Under these conditions the heavy scale on rolled-iron rods is completely removed in from 2 to 3 minutes. The chemical reaction which takes place is interesting, since the disappearance of the scale is not due to the reduction of the oxide to metallic iron. The oxide is reduced simply to a lower state of oxidation and electrolytically dissolved, ferrous sulphate

being produced. The solution of the oxide is effected without dissolving any of the iron, as in processes in which the article is made the anode. In patent 827,180 it is proposed to use an insoluble anode and to maintain sulphur dioxide in solution in the electrolyte, serving by its oxidation to both depolarize the anode and replenish the acid in solution. A diaphragm cell is employed, the sulphur dioxide gas being supplied to the anode compartment. By regulating the rate of supply of the gas the production of acid may be made to correspond with the rate of its consumption by the ferrous sulphate, the electrolyte thus being maintained at the proper concentration. As the amount of iron sulphate in the catholyte approaches saturation, the catholyte is withdrawn into a shallow pan and cooled to 0° C. The iron sulphate crystallizes out and the residual solution is returned to the anode compartment of the electrolytic cell.

Electroplating Cylindrical Articles.—R. C. Totten, 827,478, July 31. Application filed Jan. 31, 1905.

The apparatus is designed for uniformly plating circular or cylindrical bodies, such as metal-working rolls, treads of car-wheels, tires, pulleys, etc. The invention consists in details of construction of a revolving support for the articles to be plated, on which they rotate thus insuring the presentation of all points of the periphery of the articles toward the anode for equal lengths of time.

Sponge Plating.—F. R. Cunningham, 828,814, Aug. 14. Application filed Sept. 11, 1905.

In certain cases it is desirable to electroplate articles without suspending them in the vat containing the solution; for instance, when only a portion of the article is to be plated. Fig. 1 shows a glass tube A containing the anode 15 and a suitable quantity of the electrolyte. A sponge 8 is fixed in the terminal of the tube. By compressing the rubber ball B and immersing the brush or sponge 8 in the solution, a sufficient quantity of the latter is drawn up into tube A to partially or wholly cover the anode 15, and on applying the brush to the surface to be plated, connected with the negative pole of the supply circuit, the solution is discharged as required by the compression of the bulb. The quantity of solution applied is under complete control of the operator by means of the bulb.

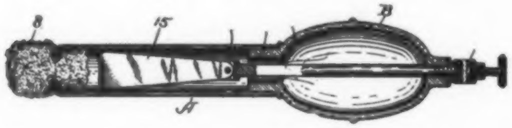

FIG. 1.—SPONG PLATING.

Production of Chlorates.—A. E. Gibbs, 827,721, Aug. 7, 1906. Application filed March 25, 1904. (Assigned to National Electrolytic Co., of Niagara Falls.)

Clorates have hitherto been produced on a commercial scale by electrolyzing a chloride solution with platinum anodes in a cell without diaphragm and crystallizing out the chlorate thus produced, the best results being obtained when the operation is conducted at temperatures of about 70° to 80° C. The object of the present invention is to substitute carbon or graphite for platinum as anode material, and it is claimed that an ampere-hour efficiency as high as 96 or 98 per cent may be obtained. Graphite, it is said, was heretofore unsatisfactory for this purpose for two reasons. First, gases evolved at the anode break away particles of the graphite, and in the case of oxygen gas oxidize it; second, the required high temperature breaks up the graphite. The first trouble is overcome by using a diaphragm cell with a solution of chloride with addition of chromate in the anode compartment; this results in the simultaneous production of chlorate and bichromate by action of the chlorine upon the chromate, so that the evolution of the gas at the anode is almost suppressed. The second trouble is overcome by conducting the electrolysis at a comparatively low temperature, preferably below 37° C., removing the liquor from the neighborhood of the anode and heating. At low temperature the chlorine evolved at the anode reacts with the chromate according to the equation

$$6K_2CrO_4 + 3Cl_2 = 3K_2Cr_2O_7 + 3KClO + 3KCl$$

A portion of the hypochlorite splits up in the cell even at the low temperature; the remainder does so when heat is applied, according to the equation

$$3KClO = KClO_3 + 2KCl$$

Some or all of the alkali formed at the cathode is allowed to react with the bichromate at the anode, according to the equation

$$2KOH + K_2Cr_2O_7 = 2K_2CrO_4 + H_2O$$

So that the chromate is continually regenerated without increase or diminution of either chromate or bichromate, while the chlorate formation proceeds.

Electrolytic Treatment of Milk.—C. T. Willson, 829,303, Aug. 21. Application filed Jan. 30, 1906.

When a direct current is passed through milk from an anode of platinum or carbon to a cathode of nickel, the curd, in a form of a white substance resembling coagulated albumen, forms at the anode and is carried by the rising gas bubbles in small flakes to the surface, where it gathers. This curd consists of the albuminoids saturated with water and other constituents of the milk in solution. This action takes place until nearly all of the casein has been gathered. The whey then consists of water containing sugar of milk in solution and the remaining albumen. The curd is then removed. The temperature of the milk is artificially held constant.

Protective Coating on Iron or Steel Objects.—H. L. Hollis, 827,802, Aug. 7. Application filed July 7, 1905.

The iron or steel object is first made cathode in a solution of a caustic alkali for the sake of cleaning; it is then made anode and by oxidation a protective coating is formed. But during the formation of this protective coating foreign substances are apt to adhere to the subject; to remove them the objects are dried and immersed for a very short time in a bath of palm oil heated to 125° C. After removing the objects from the oil bath they are brushed or rubbed with bran. The oil treatment greatly lessens the danger of marring or scratching, and the objects will also resist rust for a much longer time.

Sulphate of Copper and Caustic Alkalies.—H. M. Granier, 829,778, Aug. 28. Application filed March 12, 1904.

Sodium chloride is electrolyzed in a diaphragm cell with iron cathodes and copper anodes. The cathode compartment contains pure sodium chloride solution and the cathodic product of electrolysis is caustic soda. The anode compartment contains a solution of sodium chloride saturated with cuprous chloride Cu_2Cl_2; the anodic product of electrolysis is cuprous chloride, which is precipitated in form of a white powder. (Since the anodic chlorine is thus immediately eliminated, it cannot lead to troublesome reactions with the caustic soda formed, like formation of hypochlorite, etc.) The cuprous chloride powder is collected and washed in water. The dry powder is treated with concentrated sulphuric acid up to the calcination point, resulting in the formation of hydrochloric acid and anyhdrous copper sulphate.

GAS REACTIONS.

Ozonizer.—E. L. Joseph, 829,790, Aug. 28. Application filed Dec. 12, 1905.

By means of the fan 6, driven by the motor 7 (Fig. —) the air is sucked through the filter or drying medium 2 into the ozonizer. There the current of air is obstructed by the wooden box 11, the back 12 of which is so shaped as to break up the air current and deflect it so that it must pass around the top, bottom and sides of box 11. In each of these four passages a panel (A and C at top and bottom respectively) are provided, each comprising a pair of electrodes 14 and 15;

each is formed of a sheet of non-oxidizable metal gauze, the two sheets of gauze being placed at opposite sides of a suitable

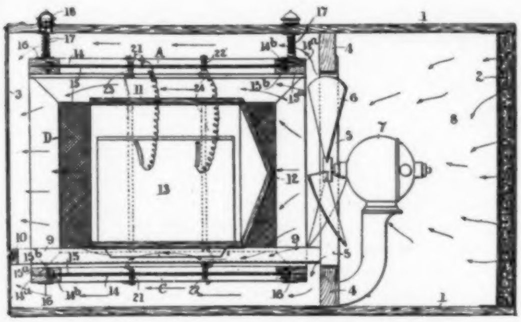

FIG. 2.—OZONIZER.

dielectric, like a sheet of mica. The two electrodes are connected with the high-tension terminals of a step-up transformer 13 in the box 11.

Combination of Gases.—D. R. Lovejoy, 829,872, Aug. 28. Application filed March 22, 1901. (Assigned to Atmospheric Products Co.)

The catalytic effect of contact substance, like platinum sponge, platinized asbestos, etc., is attributed by the inventor to their molecules being brought within acting distance of each other. To obtain the same effect it is suggested to make use of electrostatic attraction. If two gases are to combine, they are led into a chamber through separate metallic inlets which are electrostatically charged, one positive the other negative. During their passage through these inlets the molecules of one gas get positively charged, those of the other negatively charged. "On entering the chamber the positively-charged molecules of the one gas are attracted to the negatively-charged molecules of the other gas, and are thus brought within the range of attraction and a chemical combination thus effected." By this method gases may be caused to unite even when energy is absorbed by their union, as it is only necessary to charge the two sets of molecules to a sufficiently high potential, with respect to each other, to store in them sufficient energy to effect the combination after bringing them into chemical contact. Fig. 3 shows the arrangement. A is the chamber in which the gases combine. B are metallic inlets, surrounded by insulating sheaths D to prevent loss of electric charge by leakage. E are diaphragms of metallic or conducting gauze. C is the outlet for the combined gas. D and E are electrostatically charged from the dynamo F. As applications of this method the oxidation of atmospheric nitrogen and the formation of ozone are mentioned. In the latter case oxygen gas is introduced into A through both inlets B.

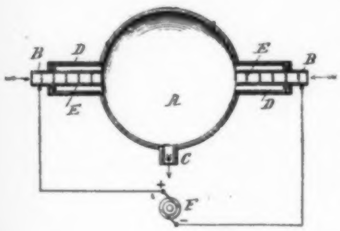

FIG. 3.—COMBINATION OF GASES.

BATTERIES.

Storage Battery.—G. A. Ford, 829,643, Aug. 28. Application filed Dec. 22, 1905.

The battery is built up of a series of plates in dish form one above the other. The plates are separated from each other by horizontal trays made of infrangible absorbent material, such as pulp board, and reinforced by a stiff frame. An electrode plate rests in each tray.

RECENT METALLURGICAL PATENTS.

SILVER.

Cyanide Process.—In connection with the article of Dr. J. W. Richards, published in this issue, on the metallurgical revolution in Guanajuato, Mex., two patents (828,287 and 828,288, of Aug. 7) are interesting, granted to Francis J. Hobson, of Guanajuato. The object is the extraction of silver from ores, in which the silver is present in combination with sulphur. The essential feature is the treatment of the ore with a solution, containing mercurous potassic cyanide, KHg Cy_2 which has a selective affinity for silver in combination with sulphur, the reaction being

$$AgS + KHgCy_2 = KAgCy_2 + HgS$$

The solvent employed by the author does not attack gold in any of the forms in which it appears to exist in the ore. (The above reaction is essentially different from the solution of gold and silver in potassium cyanide, since this requires free oxygen in the solution.) Two methods of producing the mercurous potassic cyanide are described. One way is to add mercurous chloride Hg_2Cl_2 to a solution of potassium cyanide KCy. The other way is to add mercuric chloride $HgCl_2$ to the ordinary mill cyanide solutions containing ferro-cyanide of potassium, in which case the following two reactions occur in succession:

$$KFeCy_6 + 2HgCl_2 = Hg_2FeCy_6 + 4KCl$$

and

$$Hg_2FeCy_6 + 2KCy = KHgFeCy_6 + KHgCy_2$$

The most suitable strength of the solution is to some extent dependent upon the silver content of the ore and the form in which the metal is present. The inventor has obtained good results with solutions varying from 0.05 to 0.50 per cent.

VANADIUM.

Treatment of Vanadium Ores.—J. H. Haynes and W. D. Engle (828,850, Aug. 14) crush the vanadium ore to 12-mesh and then boil it with a solution of sodium carbonate for about an hour, until the vanadium contained in the ore is brought into solution; 100 pounds of sodium carbonate for 1 ton of ore for every per cent of vanadium gives good results. All the other elements present in the ore are undissolved, and are consequently left in the residue or tailings. The solution is drawn off and the vanadium is precipitated as calcium vanadate by the addition of water-slaked lime.

ZINC.

Distillation Without Retorts.—John Armstrong (839,283, Sept. 4) patents a zinc distillation process which has that common feature with the ordinary retort process, that the zinc must be oxidized and powdered and mixed with carbon for reduction. On the other hand, the process is intended to avoid the well-known disadvantages of retorts. The purpose is to operate without the use of retorts upon a large mass of material automatically and continuously, doing away with the intermittent system of charging and discharging small quantities of material in small retorts, and establishing a continuous flow of metallic vapor into the condensers, with uniform temperature in the reducing zones of the chambers, and also in the condensers. It is also claimed that the process permits the treatment of zinc ores containing lead with or without other metals. The furnace is constructed with upright chambers or cells, which are comparatively long, narrow and high, and are built with heating flues around them for the purpose of heating them by means of gas. The chambers are constructed in a row, and are surmounted by hoppers for charging. The charge after passing down through the long chamber, falls upon a revolving discharging apparatus, which discharges the exhausted residues, while a continuous supply of material is fed in at the hoppers at the top. The region of greatest heat is toward the lower portion of the chamber, the gas burners being provided at the bottom. The vapors are given off and pass through gills in the walls into a condenser filled with

coke or anthracite, where the metallic vapors descend, and are condensed into the metallic liquid state and percolate through the apertures in the bottom of the condenser. The carbon monoxide gas is carried away from the condenser under a baffle-wall up into an exit tube. The gills in the walls between the reduction chamber and the condenser have a cross-section of the shape of a reverse V, serving the double purpose of keeping the coke or anthracite on one side and the powdered charge on the other without mixing and of allowing free descent to both and a clear and uninterrupted path for the metallic vapors through them. The chambers being continually full of the powdered charge up to the hopper at the top, an effectual seal is thus provided against the atmosphere entering the chambers or condenser, there being constantly a plus pressure inside these parts. The chambers being constructed comparatively narrow, the intense heat penetrates the charge so that dense metallic vapors are constantly evolved, giving a steady and regular metallic condensation without the loss in pressure and oxide, which is inevitable with the retort method.

Gold.

Treatment of Slimes.—To separate a cyanide solution from slimes, W. T. Weekly, of Kalgoorlie, Western Australia (830,388, Sept. 4), proposes a plant which, viewed as a whole, may be classed as an automatic charging and discharging slime-treating machine, which with a little driving power and a minimum of supervision handles a comparatively large quantity of slimes in a given time. It comprises a series of trays to receive the material to be filtered, these trays being suitably supported and forming a series with lower trays. Each series is reversible. When the lower trays become, by transposition, the upper ones, they are in turn charged with material. Piping is so attached that when the upper trays are charged with slime, a series of vacua may be formed (or the air pressure may be so reduced) in chambers under those trays that liquid or solution will be caused to filter through into the lower chambers (called "vacuum chambers"), and thence to a receiver or one or other of a series of receivers. The vacuum chambers have apertured top plates of strong perforated metal, over which is spread a filtering medium. The trays, or tray-supports, are arranged on standards or carriers called "trucks," adapted to move in a circuit or along any suitable course on rails. Such vibration as the trays receive in their motion is beneficial. The trucks are connected by piping to a main or central chamber or chambers, any suitable vacuum pumping means or the like being used. By arranging the tray trucks or vacuum filters in and moving them repeatedly around a circuit, the process may be carried on so as to filter from a number of trays at once, successive charges of slime being fed to each tray and the resultant cakes of mineral discharged. When it is found that by increasing the speed of rotation higher extraction results are secured, the speed is very easily raised, with the further advantage that a relatively greater weight of slime will then be treated in a given time. The trucks have perforated, or drilled shafts or the like, through which passages connecting to the trays extend. One passage is a solution-conveying passage, and the other is an air-admission passage. When a pair of filters are moved so that the upper one becomes the lower, its contents cease to be subjected to the vacuum or suction and become subjected to air pressure. This causes the cake to fall out from what has become the lower tray. The filter cakes thus fall in a given place and may be readily removed thence by any practicable means.

Furnace Construction.

Blast Furnace.—L. Heckscher (828,310, Aug. 14) describes means for cooling the walls of blast furnaces. He utilizes what is known as "outside cooling" for the protection of the brickwork of the walls, both above and below the mantle, in such a manner that the entire upright part of the furnace is cooled in addition to the bosh, thus particularly obviating the dangers due to coils in the "cooling plates," now generally embedded in the brickwork of blast furnaces.

Hot Blast.—Thomas Kiddie (830,152, Sept. 4) patents a hot blast system, in which the air from the blower is brought in contact with the heat from the waste gases of the furnace; the special feature is the endeavor to expose the air blast in a gradual manner to the waste heat of the furnace, exposing it first to the heat of the dust chamber or the flue farther from the furnace, and thereafter to the greater heat of the direct gases close to the furnace. On account of the long exposure and gradual elevation of temperature the air tube and jacketed linings are said to last longer, in comparison with the short travel at high temperatures in cast-iron pipes, as in the ordinary hot-blast stove. By introducing a damper in the furnace stack the velocity of the gases through the flues and dust chamber is decreased to a minimum, so as to insure a full utilization of the heat; by this means the amount of cold air drawn in at the feed doors is also correspondingly reduced and a more complete settling of the particles of flue-dust is obtained.

BOOK REVIEWS.

Catechism on Producer Gas. By Samuel S. Wyer, M. E. New York: McGraw Publishing Co. 42 pages. Illustrated. Price, $1.00 net.

This little book, which fully explains the fundamental principles of gas producers for power and fuel purposes, ought to be in the hands of every prospective user of power, as it explains in a simple way the chemistry and mechanical principles of gas producers. It enables the reader to understand the pros and cons of gas producer builders, and to form an opinion of his own. On that account this booklet will do a good deal towards educating the public in the gas power question, which certainly is now of general interest.

Illustrated Technical Dictionary. In six languages: English, German, French, Russian, Italian, Spanish. By K. Deinhardt and A. Schlomann. Vol. I.: Elements of Machinery and the tools most frequently used in metal and woodworking. By P. Stülpnagel. New York: McGraw Publishing Co., 1906. 403 pages. Price, $2.00.

This is the first of a series of technical dictionaries which, according to the programme, will be at least ten in number, each volume dealing with a separate industry and being complete in itself. The first volume covers elements of machinery and machine tools.

The arrangement is novel and has various decidedly recommendable features. The main part of the volume (256 pages) is not alphabetically arranged, but is classified rather like a hand-book. This part consists of three main divisions. The first division deals with machine elements and is sub-divided into twenty-three chapters, treating respectively with screws and bolts, keys, rivets, etc. The second division deals with tools, and is sub-divided into sixteen chapters, treating respectively with vises, tongs, anvils, etc. The third division is an appendix, dealing with engineering, drawing and miscellaneous matters.

Each chapter again contains the chief technical terms, as much as possible logically arranged. Each word is given in German, English, French, Russian, Italian and Spanish. Thus, to select one chapter at random, chapter 8 on couplings, enumerates the different types of couplings used in practice. The most remarkable and novel feature is, however, the general use of diagrams, formulas and symbols to explain the different terms. Thus in chapter 8 the different types of couplings are each illustrated by a diagram. Moreover, in drawings of more complicated apparatus the different parts are marked by letters, and in translating the terms for the different parts reference is made to these letters. This system has been carried out with great consequence and with so much

success that the authors could have claimed to give not only a dictionary in the six languages—English, German, French, Russian, Italian, Spanish—but one which translates all these languages into a seventh one, the universal language of engineers the world over—that of diagrams and formulas.

The second main part of the book (147 pages) contains two alphabetical indexes of all the words contained in the volume, one index comprising the German, English, French, Italian and Spanish languages, while for the Russian language a separate index is provided (on account of the different type). In this way it is easy to find any word in the first, hand-book-like part of the book, and the single volume, arranged according to this system replaces thirty bilingual dictionaries.

With respect to accuracy of translation the dictionary is excellent. We might almost say it is the first reliable technical dictionary that we have seen. The trouble with almost all technical dictionaries seems to be that when a new term appears and the author of a dictionary wants to take it in and does not know its meaning, he does not always take sufficient trouble to inquire of a responsible party, since it is so much easier to make a literal translation. Now, this is bad enough, but what is worse, "es erben sich Gesetz und Rechte wie eine ewige Krankheit fort," and it seems to be the same with terms in technical dictionaries; for when once such a foolish literal translation has appeared in one dictionary the authors of all others almost invariably copy it for their next "revised and enlarged" edition. This is the only explanation why a series of technical dictionaries give, for instance, as translation of "Drehstrom" the literal translation "rotatory current," which is even found in the latest special electrical dictionary, that by P. Blaschke, with a preface by Prof. F. Niethammer.

The dictionary under review is absolutely free from such ridiculous nonsense. We have found it reliable wherever we have used it. The only instance that might be mentioned in this connection is the English translation of "Flusseisen" (page 213), which is given as "ingot-iron." This is correct, since it is the officially adopted English term. But it is, nevertheless, a fact that it is scarcely used in this country, and that American iron and steel men almost invariably speak of "soft steel" or "mild steel" where the Germans speak of "Flusseisen."

Fuel Briquetting.

The problem of making briquettes has attracted numerous inventors, since its successful solution gives commercial value to the large quantities of fine ores or fine fuel, which are otherwise commercially valueless. We are glad to report some interesting recent developments in the introduction of the Mashek system of fuel briquetting.

The Traylor Engineering Co., of New York City, which has recently begun the manufacture of fuel briquetting machinery, and the installation of fuel briquetting plants under the Mashek system of briquetting, has already received several important orders. Three of these orders, for which the machinery is now being built at the company's works at Allentown, Pa., are, respectively, for Edward B. Arnold, No. 1 Broadway, New York, for his plant at the foot of West Forty-eighth Street, New York; the Semet-Solvay Co., for its Detroit plant; and the Montreal Light, Heat & Power Co., of Montreal, Canada.

These plants represent three interesting variations of the briquetting industry. Mr. Arnold is a large coal dealer. His plant is to make briquettes for domestic consumption, using the small sizes of anthracite coal. The Semet-Solvay Co. will make first-class fuel for domestic use from the coke breeze, which is a waste product from the Solvay by-product coke ovens, and the Montreal Light, Heat & Power Co. will make a smokeless briquette for family use from coke breeze resulting from gas making, using coal-tar pitch as a binder.

The adoption of the Mashek process and machinery by these three concerns is of particular significance, because each of them has been experimenting for a long time with the best and most used European briquetting machinery and machinery of other design until they were all of them conversant with every system in use. Although the foreign process and machinery may be satisfactory abroad, they have proved somewhat like a commercial failure here. The briquettes produced are not of a size or shape to suit American consumers, most of them requiring to be broken up before use. Their cost also was too great, because of the small production of the plants, the large amount of binder required, and the cost of the necessary attendance.

The Mashek plants and machinery are entirely automatic in their operation, no hand labor being required from the time the materials are received until the finished briquettes are ready to be delivered to the consumers. The briquettes are of a size and shape suitable for immediate use and convenient to handle by chute or shovel, and the production is nearly as large per hour as is the daily output of the foreign-built plants. The briquettes are as hard and clean as anthracite coal and equal the best qualities of anthracite for use.

The cost of briquetting under this system has been demonstrated in plants now in operation to be from 76 cents to 92 cents per ton, including pitch for binder, fuel for the boilers, dryers and heaters, lubricating oil, wear and tear and labor—in fact, including everything but the cost of the raw material to be briquetted. The system operates equally well on anthracite or bituminous coal, coke breeze or lignite. The design of the machinery and the installation of plants is under the personal supervision of Mr. G. J. Mashek, the inventor and patentee of this process and machinery.

Heavy Rolling-Mill Engine.

The Allis-Chalmers horizontal type rolling-mill engines have been for years used in many of the largest iron and steel mills of the country. Two units, larger than any heretofore built, however, were ordered some time ago for the Sharon, Pa., plant of the Carnegie Steel Co.. and are now being built at the West Allis Works of the Allis-Chalmers Co., Milwaukee.

The engine frame and slide for the first engine was recently cast at the West Allis foundries, and has proved to be the largest and heaviest single piece ever poured in these shops, where monster engine castings of every size and kind are produced daily. The single piece for frame and slide in this case, however, weighed, roughly, 105 tons, and is designed for an engine whose cylinders will measure 50 inches and 78 inches in diameter and have a stroke of 60 inches.

The pattern for this single casting measured 32 feet long, 11 feet wide and 10 feet high, representing the work of ten expert pattern makers for a period of over four months. The amount of lumber used in its construction reached the surprising aggregate of 22,000 feet and over. The pit in which the casting was poured measured 40 feet long, 15 feet wide and 11 feet deep, into which were poured some 105 tons or more of molten metal, the pouring of which consumed some 8 or 10 minutes' time. Nine ladles, four with a capacity of 25 tons each, one 13 tons and four 5 tons each, were used in the operation.

In building a rolling-mill engine with a capacity like the one in question, there is a marked advantage in designing the frame and parts in a single piece for the purpose of securing the greatest possible rigidity to withstand the racking strains of rolling mill service. The remarkable size of this piece, however, required an extra expense of ingenuity in the handling of it during and after its production, which might well have proven a serious question. In the first place, a weight of this kind being very exceptional, extra precautions were taken against any mishaps in the process. Three cranes, with ample overload capacities and a rated aggregate of 145 tons, were used in conjunction to lift the casting from its pit. A

special tackle was devised so that the lifts should be straight upward, applied at the ends of the heaviest or trussed steel lifting bars.

The casting, after being deposited beside its pit, was allowed to cool for fifteen days before the operation of cleaning it was begun. The heat still given off after approximately twenty days' cooling could be felt several feet away from the huge mass. During the cleaning process, three men were able to work abreast inside the slide aperture while standing upright and without perceptible crowding.

In anticipation of the difficulty of handling a piece of this size, special cars, two in number, were ordered. One of these cars is to be used to carry the casting to its destination. In handling the huge mass after cleaning, nothing but a straight lift was attempted to load it upon the special car mentioned, which was brought to the side of its prospective burden over new and special track. The car was then used to convey the casting to machine shop No. 1, where the process of machining is now going on. The mass of metal is placed upon the floor of the machine shop and the heavy machine tools used in the finishing are brought to it.

PROGRESS THROUGH THE WORKS OF A 105-TON CASTING FROM FRAME AND SLIDE OF HORIZONTAL ROLLING-MILL ENGINE.

The cars mentioned as being specially built for the Allis-Chalmers Company are unique in design and appearance, so they deserve brief mention. They are the concrete results obtained from the solving of a difficult transportation problem which confronted the engine builders. The question of adequate carrying facilities for heavy engine parts has become more and more persistent with the growth of the present tendency toward giant units. The cars used heretofore for the purpose, constructed of heavy material and with capacities of from 60 to 70 tons, having proven inadequate. The cars utilized up to the present time were, in fact, identical with those employed by the Government for the transportation of heavy ordnance. In seeking a suitable means for overcoming the difficulty of shipping such a piece, it was learned that no single car had ever been built with a capacity capable of carrying it, so that a special car, designed particularly for the purpose, would be the only possible solution. Accordingly, orders were placed for two 16-wheel flat cars of 100 tons capacity, which are the first of their kind in existence. A few details of construction showing the unusual sizes of these cars are as follows:

Length over end sills, 40 feet 2 inches.
Width over side sills, 8 feet 9 inches.
Height, rails to floor, 4 feet 4½ inches.
Wheel base, 36 feet 2 inches.
Wheels, diameter, 33-foot stand.
Journals, 5½ inches x 10 inches.
Weight of car estimated between 50,000 and 60,000 pounds.
Rated capacity, 200,000 pounds.

Magnetic Thermometer for Use in Hardening Steel.

At the recent York meeting of the British Association for the Advancement of Science, Mr. W. Taylor described an ingenious magnetic indicator of temperature, for use in hardening steel.

In his first experiments, the steel bar to be hardened was part of a magnetic circuit energized by an alternating-current coil on the yoke. Another bar, outside the furnace for heating the bar to be hardened, was in magnetic parallel with the steel bar. Each of these bars in parallel are surrounded by what may be called secondary coils, connected in series so that the currents induced in them are in opposition; the coils being such that, when the bars are cold, the induced currents are equal and opposite, and therefore no sound is perceptible in a telephone kept in the electric circuit.

Now since, for the purpose of hardening, steel has to be raised to about the temperature at which it loses most of its permeability, and since the loss of permeability by the heated steel destroys the balance of the induced currents described above, therefore the appearance of sound in the telephone gives notice of the moment for quenching the steel.

A rougher form of apparatus, which has been in daily use in the tool room for about four months, was described by the author. In this a permanent magnet produces a flux through a good magnetic circuit that includes the steel to be hardened. An alternative path is offered to the flux, but this path contains normally a small air-gap, which, however, can be closed by the rocking of an iron lever pivoted at its center at one end of the permanent magnet. Each half of the rocking lever is part of the two magnetic circuits mentioned. When the steel is heated till it loses its permeability the flux through the alternative path becomes big enough to rock the lever, and this rings a bell to notify the workman.

Notes.

Jubilee of the Coal-Tar Industry.—The Perkin memorial and international jubilee of the coal-tar color industry was recently celebrated in London. The American celebration is to take place in the Chemists' Club, New York City, Oct. 6. The next meeting of the American Electrochemical Society will be held at Columbia University, New York City, on Oct. 8 and 9, so as to give members an opportunity to attend both occasions. Full programs will be given in our next issue.

Belt Conveyors.—Bulletin No. 14 of the Robins Conveying Belt Co. gives a concise description of the design and operation of Robins belt conveyors in handling excavated earth and rock and concrete materials, with some very interesting illustrations of equipments in actual practice.

Filter Papers.—We have received samples and price lists of "ashless, chemically pure, toughened and starch-free" filter papers, made by Max Dreverhoff, in Dresden, Germany. This concern is represented in this country by George D. Feidt & Co., of Philadelphia.

Earthenware Exhausters.—We have received a reprint of a paper by Prof. George Lindner, on comparative trials of earthenware exhausters of the Deutsche Steinzengwaarenfabrik für Canalisation und Chemische Industrie of Friedrichsfeld, in Baden, Germany, which concern is represented in this country by Messrs. Fred. Bertuch & Co., of New York City. The paper of Prof. Lindner had been originally published in the *Chemical Trade Journal*, and gives a full account of the tests in form of tables and diagrams.

Courses in Industrial Chemistry.—The Pratt Institute, of Brooklyn, N. Y., has isued an illustrated pamphlet on their two-year day course in industrial chemistry and their three-year evening course in technical chemistry. Classes begin work on Sept. 24 and 26 respectively. The pamphlet contains, besides a program of the courses, an illustrated description of the equipment of the chemical laboratories of Pratt Institute.

OIL ENGINES.—The borough of Kutztown, Pa., after operating a municipal lighting plant for some time, is increasing its capacity by the installation of a 125-hp. Hornsby-Akroyd oil engine. The present plant consists of a 65-hp. Hornsby-Akroyd oil engine belted to generator. Both engines were supplied by the De La Vergne Machine Co., New York. This company has recently issued a nicely illustrated pamphlet on the Hornsby-Akroyd oil engine, its design and operation. The ability of this engine to run successfully on crude and fuel oil places it in a class by itself, and has been no small factor in bringing about the installation of over 14,000 engines which are now in successful operation. These engines are built by the De La Vergne Machine Co., in single cylinder units up to 125 hp. in size, and in twin cylinder units up to 250 hp.

STEEL-HARDENING METALS.—A recent pamphlet of the United States Geological Survey deals with the production of steel-hardening metals in 1905, J. H. Pratt being the author. The following metals are dealt with, figures being given for home production and importation: Nickel and cobalt, chromium, tungsten, molybdenum, vanadium and uranium, titanium. Of these only tungsten is produced from ores in this country to any considerable extent, the United States production of tungsten having increased from 46 tons in 1900 to 292 in 1903, and 803 tons in 1905. Although there was only a very small production of nickel ore in the United States during 1905, there was a considerable quantity of matte and ore refined, which was imported from Canada and New Caledonia. The nickel obtained from this source is very much in excess of the quantity consumed in the United States, and there is therefore a large export of the metal.

ELECTRICAL EQUIPMENT OF IRON AND STEEL PLANTS.—We have already briefly referred to the proposed electrical equipment of the new Gary, Ind., steel plant of the United States Steel Corporation. Since this plant is a splendid illustration of the remarkable extent to which the use of electricity for power purposes has been developed in the inumerable industrial plants of the country, the following details will be of interest: When completed it is estimated that the Gary plant will handle substantially 5,000,000 tons of ore a year, and produce annually approximately 2,500,000 tons of steel. There will be sixteen blast furnaces of 450 tons daily capacity each, and eighty-four basic open-hearth furnaces of 60 tons. The necessary electrical generating equipment capable of handling such an output is to have an initial capacity of 18,000 kw., and will be so designed that extensions may be added indefinitely at one or both ends. The initial equipment will have a capacity of 18,000 kw., of which 14,000 kw. are in 2,000-kw., 25-cycle, 2,300-volt units, and 4,000 kw. in 2,000-kw., 250-volt direct-current units. These generators are now on order from the Allis-Chalmers Co., Milwaukee, and they will be direct coupled to nine Allis-Chalmers horizontal twin-tandem gas engines. The power house building for the present is to be approximately 700 feet long, with a span in the main building of 88 feet. An 18-foot extension under the same roof through the entire length of the structure, has been planned in order to provide the necessary room for high-tension switches. The power house will be located immediately adjacent to the blast furnace blowing engine houses, and between the blast furnaces and the open-hearth furnaces, most advantageously placed for fuel supply and for securing a minimum length of transmission lines to the various departments using electric power. The Allis-Chalmers alternators and direct-current generators will be built at the company's electrical works in Cincinnati.

The TRAYLOR ENGINEERING Co. and the Traylor Manufacturing & Construction Co. have been consolidated into one corporation, under the name of the Traylor Engineering Co. The new corporation is organized under the laws of the State of New York. The public will continue to find the Traylor Engineering Co. at its offices in the Engineering Building, 118 Liberty Street, New York, and with its constantly increasing staff of experts always ready to give advice on mining, metallurgical, cement making, fuel briquetting and rock-crushing matters. The Traylor Engineering Co. has also recently entered into a contract whereby Shirley & Grant, of Reno, Nev., become exclusive representatives of that house for the State of Nevada, for the sale of their machinery for mining, sampling, rock and ore crushing, milling, cyaniding, amalgamating, smelting, refining, fuel briquetting and cement making. A close relationship has been established under which the two houses will co-operate in designing and building entire plants, as well as in the sale of individual pieces of machinery. Shirley & Grant are well known in the Nevada territory, both as a firm and as individuals, and they have many friends among the mining fraternity. Messrs. Victor M. Braschi & Co., of the City of Mexico, who also represent the Ingersoll-Rand Co., the A. S. Cameron Steam Pump Works, and the Erie City Iron Works, have taken an extensive agency for the Traylor Engineering Company in Mexico.

LUNGWITZ ZINC PROCESS.—As our readers will remember, a large-scale test was made last year at Warren, N. H., with the Lungwitz zinc process, the essential feature of which is the attempt to smelt zinc ores in a blast furnace under strong pressure so as to get the zinc in liquid form. Last year the tests were checked by various difficulties, and the results of the tests were believed not to be conclusive. Now these tests are to be resumed shortly.

AMERICAN MINING CONGRESS.—The annual meeting of the American Mining Congress will be held in Denver, Col., from Oct. 16 to 19.

DRY BLAST.—The first European application of the Gayley dry-blast process will be made at the works of Guest, Keen & Nettlefords, in Dowlais.

THINGS CHEMICAL.—This monthly trade publication of the Charles E. Sholes Co., of New York City, continues to bring interesting matter in form of short notes from chemical practice (for instance, on pickling and galvanizing iron, in the July issue, denaturized alcohol versus turpentine in the August issue). Other notes are written in a quite amusing style, and on the whole the publication is extremely well edited in the interest of the concerns which it represents. After the May issue had brought the portrait of Mr. Charles E. Sholes, the July issue contains that of Mr. Edward J. Duggan, vice-president of the Charles E. Sholes Co.

ANALYZED CHEMICALS.—A small but interesting booklet, entitled *Baker's Analyzed Chemicals,* contains the detailed analyses of 161 chemically pure products of the J. T. Baker Chemical Co., of Easton, Pa. The analyses are given to show the presence or absence of suspected impurities and estimation of quantities when present. The figures given show the average results obtained from different lots.

LARGE ELECTRIC STEEL PLANT FOR SWEDEN.—According to the Stockholm correspondent of the *Frankfurter Zeitung,* there is a probability that the Kjellin electric furnace for the production of steel will be utilized on a much larger scale than heretofore in Sweden. A number of capitalists are said to have proposed to the Swedish government to organize a stock company to make steel under the Gröndal-Kjellin patents, provided the government will develop the immense water power at the Tralhätta waterfall, and also that in the Province in Norrland, in which there are extensive ore deposits. It is proposed to lease these water powers from the government, and to produce steel in such quantities as to make Sweden a steel-exporting country. The power from the Tralhätta Fall will be brought to a point near Gothenburg, where a steel plant producing 500,000 tons yearly, according to the optimistic claims of the promoters, will be established. The works in Norrland will have about the same capacity. The two, it is claimed, will be able to supply all the steel required for home consumption, and it is hoped that the steel will be cheap enough to make export possible. The government is said to have accepted the proposi-

tion, and to have decided to commence work to develop power at the Tralhätta Fall. It is expected that 10,000 to 15,000 hp. will be available there as early as the year 1908. The new company has been given the title "Metallurgiska Patent Aktiebolaget." The Krupp works is reported to have acquired the Kjellin patents for Germany, and it is proposed to erect a plant for their utilization. In connection with these notes, which we find in *Iron Age*, it may be remarked that the process of Groendal, alluded to above, is for concentrating and briquetting iron ores, while the Kjellin process is for refining steel in an electric induction furnace; it has been described in detail repeatedly in this journal.

Coöperation in Physical Chemistry.—At the recent meeting of the American Chemical Society in Ithaca, Prof. W. D. Bancroft made some timely suggestions on coöperation in physical chemistry, as summarized in a recent issue of *Science:* We could be of more assistance to each other if we had a system of reports by which we knew what bits of research work the others were doing. Each has stored away in his memory a number of generally unfamiliar facts which he has stumbled upon in his reading or in his laboratory. These may not be important enough to him to justify his doing enough work to get anything worth publishing, or he may have more important matters on hand and so lack the time. If now any one of us learns that any one of the others is doing a bit of investigation into which this, that, or the other fact fits nicely, the observation can at once be turned over to the man who can use it, much to the benefit of both parties. It is probable that nobody goes to one of the meetings of the Chemical Society without getting a few suggestions of value to him. On the other hand, owing to the great distances and consequent expense, we do not get together as often as we should like. If we kept more in touch, we should be getting continually some of the advantages which we now get from the occasional meetings. The matter would not be difficult to arrange. In October and February each man could make out a list of the work planned or in operation. These reports could be manifolded and distributed. So far as I can see, the plan has practically no objectionable features and might be of great value. It seems, therefore, worth trying.

"By-Products."—According to the *Chemische Zeitschrift*, the following very interesting remarks were made by Commercienrat Grimberg, of Zeche Lothringen, in Bochum, Germany: Prof. Ostwald's contact process for winning nitric acid from coke-oven gases will be used on a large scale in a plant which will cost about $90,000, and which will be ready by Nov. 1. That tar, ammonia, benzene are somewhat more than "by-products," is shown by the annual report of the Gewerkschaft König Ludwig. The annual profit of $400,000 was made up of $167,500 from coal mining, $39,425 from coke making, and some $185,000 from the by-products, which, therefore, made up almost half the profit. Throughout the Ruhr mining district new plants are being erected, and the by-product coke oven installations are constantly increasing in number and importance.

Aluminium in Europe.—Like the Pittsburg Reduction Co. in this country, the British Aluminium Co. finds it necessary to increase the capacity of their works. Having fully utilized the power from the Falls of Foyers in Inverness-shire, they have commenced a far more ambitious scheme. In the neighborhood of Kinlochleven is an area which has one of the largest rainfalls in the whole of the British Isles. The catchment basin in the position chosen has a large area, in the center of which is the site for the reservoir, at an elevation of 1,000 feet above the sea level, and only distant about 5 miles from the coast. According to the London *Electrician* the reservoir will be about 7½ miles in length, with an average breadth of ⅓ mile. It will obliterate three small lakes, and its capacity will be about 20,000,000,000 gallons. The dam will be formed of concrete, and will be over ½ mile in length, and its greatest height in the center will be about 80 feet. The cost of the undertaking will exceed $2,000,000.

Personal.

Prof. Max Le Blanc has been appointed Prof. Ostwald's successor at the University of Leipzig, while Prof. Fritz Haber becomes Le Blanc's successor in Karlsruhe. Both Prof. Le Blanc and Prof. Haber are members of the American Electrochemical Society. Prof. Haber is well known personally to many American electrochemists and electrometallurgists from his extended trip through this country in 1902.

Mr. W. Mc A. Johnson is leaving for an extended tour of the West, to look into the subject of zinc concentrators with reference to their bearing on the metallurgy of zinc, in connection with the continuous zinc furnace which he has developed. Mr. Johnson will visit Kansas, Colorado, New Mexico, Arizona, Nevada, British Columbia and old Mexico, and expects to return about the first of December.

Mr. H. Hullegard has opened engineering offices in Ousby, Sweden, and will be specially interested in representing American manufacturers of machinery and apparatus for metallurgical and chemical work. Mr. Hullegard is not a stranger in this country. After graduating from the Royal Technical University, in Stockholm, as chemical engineer, he came to this country in 1900, and found employment with the Orford Copper Co., in Bayonne, N. J. He worked for a number of years in their various laboratories, and was for a couple of years in charge of their plant for winning the precious metals, gold, silver, platinum and paladium, from their Canadian nickel ores. Simultaneously he carried on the company's extensive experimental work on electrolytic nickel refining, and assisted Mr. V. Hybinette in working out the practical details of his new electrolytic nickel refining process, which was described in our January issue, page 34. For some time he also had charge of the electrolytic nickel refinery. Mr. Hullegard returned to Sweden last year, and opened an engineering office, representing American, German and English manufacturers.

Digest of U. S. Patents Prior to July, 1902.

Index.

Since a large amount of material has already been published in this department, a concise index of the subjects dealt with in the past should be useful, no such index having been given before: